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| <p>(21) International Application Number: PCT/US98/22486</p> <p>(22) International Filing Date: 23 October 1998 (23.10.98)</p> <p>(30) Priority Data:</p> <table border="0"> <tr> <td>08/956,323</td> <td>23 October 1997 (23.10.97)</td> <td>US</td> </tr> <tr> <td>08/956,564</td> <td>23 October 1997 (23.10.97)</td> <td>US</td> </tr> <tr> <td>08/956,324</td> <td>23 October 1997 (23.10.97)</td> <td>US</td> </tr> </table> <p>(71) Applicant (for all designated States except US): THE PROCTER & GAMBLE COMPANY [US/US]; One Procter & Gamble Plaza, Cincinnati, OH 45202 (US).</p> <p>(72) Inventors; and</p> <p>(75) Inventors/Applicants (for US only): GHOSH, Chanchal, Kumar [BD/US]; 7005 Pinemill Drive, West Chester, OH 45069 (US). BAECK, Andre, Cesar [BE/BE]; Putssteenweg 273, B-2820 Bonheiden (BE). OHTANI, Ryohi [JP/JP]; 7-19, UedaNaka-machi, Nishinomiya, Hyogo, Kobe (JP). BUSCH, Alfred [DE/BE]; Handelstraat 210, B-1840 Londerzeel (BE). SHOWELL, Michael, Stanton [US/US]; 685 Compton Road, Cincinnati, OH 45231 (US).</p> <p>(74) Agents: REED, T., David et al.; The Procter & Gamble Company, 5299 Spring Grove Avenue, Cincinnati, OH 45217-1087 (US).</p> | 08/956,323 | 23 October 1997 (23.10.97) | US | 08/956,564 | 23 October 1997 (23.10.97) | US | 08/956,324 | 23 October 1997 (23.10.97) | US | <p>(81) Designated States: AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p>Published Without international search report and to be republished upon receipt of that report.</p> |
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| 08/956,324 | 23 October 1997 (23.10.97) | US | | | | | | | | |
| (54) Title: MULTIPLY-SUBSTITUTED PROTEASE VARIANT AND AMYLASE VARIANT-CONTAINING CLEANING COMPOSITIONS | | | | | | | | | | |
| (57) Abstract | | | | | | | | | | |
| <p>The present invention relates to cleaning compositions comprising a protease variant. One cleaning composition comprises a protease variant including a substitution of an amino acid residue with another naturally occurring amino acid residue at an amino acid residue position corresponding to position 103 of <i>Bacillus amyloliquefaciens</i> subtilisin in combination with a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 1, 3, 4, 8, 9, 10, 12, 13, 16, 17, 18, 19, 20, 21, 22, 24, 27, 33, 37, 38, 42, 43, 48, 55, 57, 58, 61, 62, 68, 72, 75, 76, 77, 78, 79, 86, 87, 89, 97, 98, 99, 101, 102, 104, 106, 107, 109, 111, 114, 116, 117, 119, 121, 123, 126, 128, 130, 131, 133, 134, 137, 140, 141, 142, 146, 147, 158, 159, 160, 166, 167, 170, 173, 174, 177, 181, 182, 183, 184, 185, 188, 192, 194, 198, 203, 204, 205, 206, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 222, 224, 227, 228, 230, 232, 236, 237, 238, 240, 242, 243, 244, 245, 246, 247, 248, 249, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 265, 268, 269, 270, 271, 272, 274 and 275 of <i>Bacillus amyloliquefaciens</i> subtilisin; wherein when said protease variant includes a substitution of amino acid residues at positions corresponding to positions 103 and 76, there is also a substitution of an amino acid residue at one or more amino acid residue positions other than amino acid residue positions corresponding to positions 27, 99, 101, 104, 107, 109, 123, 128, 166, 204, 206, 210, 216, 217, 218, 222, 260, 265 or 274 of <i>Bacillus amyloliquefaciens</i> subtilisin; and one or more cleaning adjunct materials. Another cleaning composition comprises a protease variant including a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 62, 212, 230, 232, 252 and 257 of <i>Bacillus amyloliquefaciens</i> subtilisin; an amylase variant and one or more cleaning adjunct materials. Methods for using the cleaning compositions are also provided.</p> | | | | | | | | | | |

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MULTIPLY-SUBSTITUTED PROTEASE VARIANT AND AMYLASE VARIANT-CONTAINING CLEANING COMPOSITIONS

FIELD OF THE INVENTION

The present invention relates to cleaning compositions which comprise one or more protease enzymes which are multiply-substituted protease variants and one or more amylase enzymes which are amylase variants. More particularly, the present invention relates to laundry detergent compositions, dishwashing detergent compositions, hard surface cleaning compositions and personal cleansing compositions which comprise one or more multiply-substituted protease variants and one or more amylase variants.

BACKGROUND OF THE INVENTION

Various types of enzymes have long been used in laundry detergents to assist in the removal of certain stains from fabrics. Each class of enzyme (amylase, protease, etc.) generally catalyzes a different chemical reaction. For example, protease enzymes are known for their ability to hydrolyze (break down a compound into two or more simpler compounds) other proteins. This ability has been taken advantage of through the incorporation of naturally occurring or engineered protease enzymes to laundry detergent compositions.

In recent years the use of enzymes has also been investigated for use in automatic dishwashing compositions. Unfortunately, many enzymes, such as many conventional protease enzymes, do not translate well into the wash environment. Specifically, thermal stability, pH stability, oxidative stability and substrate specificity need to be optimized to ensure satisfactory performance.

U.S. Patent No. RE 34,606 to Estell et al. discloses the modification of subtilisin amion acid residues corresponding to positions in *Bacillus amyloliquefaciens* subtilisin tyrosine -1, aspartate +32, asparagine +155, tyrosine +104, methionine +222, glycine +166, histidine +64, glycine +169, phenylalanine +189, serine +33, serine +221, tyrosine +217, glutamate +156 and alanine +152.

U.S. Patent No. 5,182,204 discloses the modification of the amino acid +224 residue in *Bacillus amyloliquefaciens* subtilisin and equivalent positions in other subtilisins which may be modified by way of substitution, insertion or deletion and which may be combined with modifications to the residues identified in U.S. Patent No. RE 34,606 to form useful subtilisin mutants or variants. U.S. Patent No. 5,182,204 further discloses the modification of many amino acid residues within subtilisin, including specifically +99, +101, +103, +107, +126, +128, +135, +197 and +204.

U.S. Patent No. 5,679,630 to Baeck et al. discloses cleaning compositions comprising a protease variant including substitutions of amino acid residues with other amino acid residues at positions corresponding to position 76 in combination with one or more of the following positions 99, 101, 103, 104, 107, 123, 27, 105, 109, 126, 128, 135, 156, 166, 195, 197, 204, 206, 210, 216, 217, 218, 222, 260, 265 and/or 274 of *Bacillus amyloliquefaciens* subtilisin, and one or more cleaning composition materials.

In addition to protease enzymes, amylase enzymes have been used for a variety of different purposes, the most important of which are starch liquefaction, textile desizing, starch modification in the paper and pulp industry, and for brewing and baking. A further use of amylases, which is becoming increasingly important, is the removal of starch containing soils and stains during the washing of fabrics, hard surfaces, and/or dishes.

WO 94/18314 (Genencor) published August 18, 1994, WO 94/02596 (Novo) published February 3, 1994, and WO 95/10603 (Novo) published April 20, 1995, describe cleaning compositions which incorporate mutant amylases.

Other amylases known for use in cleaning compositions include both α - and β -amylases. α -Amylases are known in the art and include those disclosed in U.S. Patent Nos. 5,003,257; EP 252 666; WO 91/00353; FR 2,676,456; EP 285 123; EP 525 610; EP 368 341; and British Patent Specification No. 1,296,839 (Novo).

WO 95/26397 (Novo) published October 5, 1995 discloses an α -amylase having a specific activity at least 25% higher than the specific activity of Termamyl[®] at a temperature range of 25°C to 55°C and at a pH value in the range of 8 to 10.

WO 98/05748 (P&G) published February 12, 1998 discloses variants of the α -amylases described in WO 95/26397 used in detergent compositions.

WO 98/30669 (Henkel) published July 16, 1998 discloses a protease and amylase-containing detergent composition wherein the protease is a protease mutant in which the amino acid leucine present in position 211 (BLAP counting method) in the wild-type protease is exchanged at this location for an aspartic acid or glutamic acid, and the amylase is an amylase mutant in which at least one methionine, tryptophan, cysteine or tyrosine present in the wild-type amylase is removed or exchanged for another amino acid which is in particular not cysteine or methionine. Examples of amylase mutants suitable for use in

the compositions of WO 98/30669 are disclosed in WO 94/02597 (Novo), WO 95/10603 (Novo) and WO 94/18314 (Genencor) and are commercially available as Duramyl® (Novo) and Purafect OxAm® (Genencor).

However, there continues to exist a consumer need for cleaning compositions that provide more enhanced and/or improved cleaning (removal and/or reduction) of soils and/or stains from substrates over conventional enzyme-containing cleaning compositions.

By the present invention, it has been found that the combination of novel protease enzymes which are multiply-substituted protease variants and amylase enzymes which are amylase variants, especially α -amylase variants, provide enhanced and/or improved soil and/or stain removal benefits over conventional enzyme-containing cleaning compositions and/or over cleaning compositions containing the novel protease enzymes of the present invention in the absence of the amylase enzymes of the present invention.

Further, it has been surprisingly found that cleaning compositions comprising the novel combination of the novel protease enzymes of the present invention with the amylase enzymes of the present invention provide superior cleaning benefits over the cumulative cleaning benefits provided by cleaning compositions comprising one or the other, but not both, of the novel protease enzymes of the present invention or the amylase enzymes of the present invention.

Accordingly, it is an object of the present invention to provide cleaning compositions, especially laundry detergent compositions and/or dishwashing detergent compositions, having improved soil and/or stain removal benefits and/or fabric cleaning benefits.

Further, the specific combinations claimed in the present application are not identified in any of these prior art references.

SUMMARY OF THE INVENTION

The present invention meets the aforementioned needs in that it has been surprisingly discovered that the multiply-substituted protease variants of the present invention, when used in combination with the amylase variants of the present invention in cleaning compositions provide improved and enhanced cleaning ability, including, but not limited to, stain and/or soil removal and/or reduction and/or whiteness maintenance and/or dingy cleanup and/or spot and/or film removal and/or reduction, over conventional enzyme-containing cleaning compositions.

The multiply-substituted protease variants and amylase variants of the present invention are suitable for use in high and low density granular, heavy duty and light duty liquids, tablets, as well as synthetic detergent bar compositions, and other cleaning compositions.

In one aspect of the present invention a cleaning composition comprising:

(a) a protease variant, preferably an effective amount of a protease variant, more preferably from about 0.0001% to about 10% by weight of the cleaning composition of a protease variant, wherein said protease variant includes a substitution of an amino acid residue with another naturally occurring amino acid residue at an amino acid residue position corresponding to position 103 of *Bacillus amyloliquefaciens* subtilisin in combination with a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 1, 3, 4, 8, 9, 10, 12, 13, 16, 17, 18, 19, 20, 21, 22, 24, 27, 33, 37, 38, 42, 43, 48, 55, 57, 58, 61, 62, 68, 72, 75, 76, 77, 78, 79, 86, 87, 89, 97, 98, 99, 101, 102, 104, 106, 107, 109, 111, 114, 116, 117, 119, 121, 123, 126, 128, 130, 131, 133, 134, 137, 140, 141, 142, 146, 147, 158, 159, 160, 166, 167, 170, 173, 174, 177, 181, 182, 183, 184, 185, 188, 192, 194, 198, 203, 204, 205, 206, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 222, 224, 227, 228, 230, 232, 236, 237, 238, 240, 242, 243, 244, 245, 246, 247, 248, 249, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 265, 268, 269, 270, 271, 272, 274 and 275 of *Bacillus amyloliquefaciens* subtilisin; wherein when said protease variant includes a substitution of amino acid residues at positions corresponding to positions 103 and 76, there is also a substitution of an amino acid residue at one or more amino acid residue positions other than amino acid residue positions corresponding to positions 27, 99, 101, 104, 107, 109, 123, 128, 166, 204, 206, 210, 216, 217, 218, 222, 260, 265 or 274 of *Bacillus amyloliquefaciens* subtilisin;

(b) an amylase variant, preferably an effective amount of an amylase variant, more preferably from about 0.0001% to about 10% by weight of the cleaning composition of an amylase variant, wherein said amylase variant is selected from the group consisting of:

(i) α -amylase characterized by having a specific activity at least 25% higher than the specific activity of Termamyl® at a temperature range of 25°C to 55°C and at a pH value in the range of 8 to 10, measured by Phadebas® α -amylase activity assay and/or;

(ii) α -amylase according to (i) comprising the amino acid sequence shown in SEQ ID No. 1 or an α -amylase being at least 80% homologous with the amino acid sequence shown in SEQ ID No. 1 and/or;

(iii) α -amylase according to (i) comprising the amino acid sequence shown in SEQ ID No. 2 or an α -amylase being at least 80% homologous with the amino acid sequence shown in SEQ ID No. 2 and/or;

(iv) α -amylase according to (i) comprising the following amino acid sequence N-terminal: His-His-Asn-Gly-Thr-Asn-Gly-Thr-Met-Met-Gln-Tyr-Phe-Glu-Trp-

Tyr-Leu-Pro-Asn-Asp (SEQ ID No. 3) or an α -amylase being at least 80% homologous with the amino acid sequence shown (SEQ ID No. 3) in the N-terminal and/or;

(v) α -amylase according to (i-iv) wherein the α -amylase is obtainable from an alkalophilic *Bacillus* species and/or;

(vi) α -amylase according to (v) wherein the amylase is obtainable from any of the strains NCIB 12289, NCIB 12512, NCIB 12513 and DSM 935 and/or;

(vii) α -amylase showing positive immunological cross-reactivity with antibodies raised against an α -amylase having an amino acid sequence corresponding respectively to SEQ ID No. 1, ID No. 2, or ID No. 3 and/or;

(viii) variant of a parent α -amylase, wherein the parent α -amylase (1) has one of the amino acid sequences shown in SEQ ID No. 1, ID No. 2, or ID No. 4, respectively, or (2) displays at least 80% homology with one or more of said amino acid sequences, and/or displays immunological cross-reactivity with an antibody raised against an α -amylase having one of said amino acid sequences, and/or is encoded by a DNA sequence which hybridizes with the same probe as a DNA sequence encoding an α -amylase having one of said amino acid sequences, in which variants: (A) at least one amino acid residue of said parent α -amylase has been deleted; and/or (B) at least one amino acid residue of said parent α -amylase has been replaced by a different amino acid residue; and/or (C) at least one amino acid residue has been inserted relative to said parent α -amylase; said variant having an α -amylase activity and exhibiting at least one of the following properties relative to said parent α -amylase: increased thermostability; increased stability towards oxidation; reduced Ca ion dependency; increased stability and/or α -amylolytic activity at neutral to relatively high pH values; increased α -amylolytic activity at relatively high temperature; and increase or decrease of the isoelectric point (pI) so as to better match the pI value for α -amylase variant to the pH of the medium; and

(c) one or more cleaning adjunct materials.

In yet another aspect of the present invention, a fabric cleaning composition comprising:

(a) a protease variant, preferably an effective amount of a protease variant, more preferably from about 0.0001% to about 10% by weight of the fabric cleaning composition of a protease variant, wherein said protease variant is as described above;

(b) an amylase variant, preferably an effective amount of an amylase variant, more preferably from about 0.0001% to about 10% by weight of the cleaning composition of an amylase variant, wherein said amylase variant is as described above;

(c) at least about 5% by weight of the fabric cleaning composition of a surfactant; and

(d) at least about 5% by weight of the fabric cleaning composition of a builder,

is provided.

In still another aspect of the present invention, a method for cleaning a fabric in need of cleaning comprising contacting the fabric with the fabric cleaning composition of the present invention is provided.

In still yet another aspect of the present invention, a dishwashing composition comprising:

(a) a protease variant, preferably an effective amount of a protease variant, more preferably from about 0.0001% to about 10% by weight of the dishwashing composition of a protease variant, wherein said protease variant is as described above;

(b) an amylase variant, preferably an effective amount of an amylase variant, more preferably from about 0.0001% to about 10% by weight of the cleaning composition of an amylase variant, wherein said amylase variant is as described above; and

(c) from about 0.1% to about 10% by weight of a surfactant,
is provided.

In still yet another aspect of the present invention, a method for cleaning a dish in need of cleaning comprising contacting the dish with the dishwashing composition of the present invention is provided.

In still yet another aspect of the present invention, a personal cleansing composition comprising:

(a) a protease variant, preferably an effective amount of a protease variant, more preferably from about 0.001% to about 5% by weight of the personal cleansing composition of a protease variant, wherein said protease variant is as described above;

(b) an amylase variant, preferably an effective amount of an amylase variant, more preferably from about 0.0001% to about 10% by weight of the cleaning composition of an amylase variant, wherein said amylase variant is as described above; and

(c) from about 0.1% to about 95% by weight of the personal cleansing composition of a surfactant system; and

(d) optionally, from about 0.05% to about 50% by weight of the personal cleansing composition of an enzyme stabilizer,
is provided.

In still yet another aspect of the present invention, a method for personal cleansing of a part of the human or lower animal body in need of cleansing comprising contacting the part with the personal cleansing composition of the present invention is provided.

In still yet another aspect of the present invention, a cleaning composition comprising:

(a) a protease variant, preferably an effective amount of a protease variant, more preferably from about 0.0001% to about 10% by weight of the cleaning composition of a

protease variant, wherein said protease variant includes a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 62, 212, 230, 232, 252 and 257 of *Bacillus amyloliquefaciens* subtilisin;

(b) an amylase variant, preferably an effective amount of an amylase variant, more preferably from about 0.0001% to about 10% by weight of the cleaning composition of an amylase variant, wherein said amylase variant is selected from the group consisting of:

(i) α -amylase characterized by having a specific activity at least 25% higher than the specific activity of Termamyl[®] at a temperature range of 25°C to 55°C and at a pH value in the range of 8 to 10, measured by Phadebas[®] α -amylase activity assay and/or;

(ii) α -amylase according to (i) comprising the amino acid sequence shown in SEQ ID No. 1 or an α -amylase being at least 80% homologous with the amino acid sequence shown in SEQ ID No. 1 and/or;

(iii) α -amylase according to (i) comprising the amino acid sequence shown in SEQ ID No. 2 or an α -amylase being at least 80% homologous with the amino acid sequence shown in SEQ ID No. 2 and/or;

(iv) α -amylase according to (i) comprising the following amino acid sequence N-terminal: His-His-Asn-Gly-Thr-Asn-Gly-Thr-Met-Met-Gln-Tyr-Phe-Glu-Trp-Tyr-Leu-Pro-Asn-Asp (SEQ ID No. 3) or an α -amylase being at least 80% homologous with the amino acid sequence shown (SEQ ID No. 3) in the N-terminal and/or;

(v) α -amylase according to (i-iv) wherein the α -amylase is obtainable from an alkalophilic *Bacillus* species and/or;

(vi) α -amylase according to (v) wherein the amylase is obtainable from any of the strains NCIB 12289, NCIB 12512, NCIB 12513 and DSM 935 and/or;

(vii) α -amylase showing positive immunological cross-reactivity with antibodies raised against an α -amylase having an amino acid sequence corresponding respectively to SEQ ID No. 1, ID No. 2, or ID No. 3 and/or;

(viii) variant of a parent α -amylase, wherein the parent α -amylase (1) has one of the amino acid sequences shown in SEQ ID No. 1, ID No. 2, or ID No. 4, respectively, or (2) displays at least 80% homology with one or more of said amino acid sequences, and/or displays immunological cross-reactivity with an antibody raised against an α -amylase having one of said amino acid sequences, and/or is encoded by a DNA sequence which hybridizes with the same probe as a DNA sequence encoding an α -amylase having one of said amino acid sequences, in which variants: (A) at least one amino acid residue of said parent α -amylase has been deleted; and/or (B) at least one amino acid residue of said parent α -amylase has been replaced by a different amino acid

residue; and/or (C) at least one amino acid residue has been inserted relative to said parent α -amylase; said variant having an α -amylase activity and exhibiting at least one of the following properties relative to said parent α -amylase: increased thermostability; increased stability towards oxidation; reduced Ca ion dependency; increased stability and/or α -amylolytic activity at neutral to relatively high pH values; increased α -amylolytic activity at relatively high temperature; and increase or decrease of the isoelectric point (pI) so as to better match the pI value for α -amylase variant to the pH of the medium; and

(c) one or more cleaning adjunct materials,
is provided.

In still yet another aspect of the present invention, a fabric cleaning composition comprising:

(a) a protease variant, preferably an effective amount of a protease variant, more preferably from about 0.0001% to about 10% by weight of the fabric cleaning composition of a protease variant, wherein said protease variant includes a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 62, 212, 230, 232, 252 and 257 of *Bacillus amyloliquefaciens* subtilisin;

(b) an amylase variant, preferably an effective amount of an amylase variant, more preferably from about 0.0001% to about 10% by weight of the cleaning composition of an amylase variant, wherein said amylase variant is as described above;

(c) at least about 5% by weight of the fabric cleaning composition, of a surfactant;
and

(d) at least about 5% by weight of the fabric cleaning composition, of a builder,
is provided.

In still another aspect of the present invention, a method for cleaning a fabric in need of cleaning comprising contacting the fabric with the fabric cleaning composition of the present invention is provided.

In still yet another aspect of the present invention, a dishwashing composition comprising:

(a) a protease variant, preferably an effective amount of a protease variant, more preferably from about 0.0001% to about 10% by weight of the fabric cleaning composition of a protease variant, wherein said protease variant includes a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 62, 212, 230, 232, 252 and 257 of *Bacillus amyloliquefaciens* subtilisin;

(b) an amylase variant, preferably an effective amount of an amylase variant, more preferably from about 0.0001% to about 10% by weight of the cleaning composition of an amylase variant, wherein said amylase variant is as described above; and

(c) from about 0.1% to about 10% by weight of the dishwashing composition, of a surfactant,
is provided.

In still yet another aspect of the present invention, a method for cleaning a dish in need of cleaning comprising contacting the dish with the dishwashing composition of the present invention is provided.

In still yet another aspect of the present invention, a personal cleansing composition comprising:

(a) a protease variant, preferably an effective amount of a protease variant, more preferably from about 0.001% to about 5% by weight of the personal cleansing composition of a protease variant, wherein said protease variant includes a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 62, 212, 230, 232, 252 and 257 of *Bacillus amyloliquefaciens* subtilisin;

(b) an amylase variant, preferably an effective amount of an amylase variant, more preferably from about 0.0001% to about 10% by weight of the cleaning composition of an amylase variant, wherein said amylase variant is as described above; and

(c) from about 0.1% to about 95% by weight of the personal cleansing composition, of a surfactant system; and

(d) optionally, from about 0.05% to about 50% by weight of the personal cleansing composition, of an enzyme stabilizer,
is provided.

In still yet another aspect of the present invention, a method for personal cleansing of a part of the human or lower animal body in need of cleansing comprising contacting the part with the personal cleansing composition of the present invention is provided.

Accordingly, it is an object of the present invention to provide cleaning compositions having a combination of a protease variant and amylase variant capable of providing improved and enhanced cleaning of fabrics, dishware, tableware, kitchenware, cookware and other hard surface substrates. It is a further object of the present invention to provide methods for fabric, dishware, tableware, kitchenware, cookware and other hard surface substrate cleansing via the use of the protease variant/amylase variant-containing cleaning compositions of the present invention.

These and other objects, features and advantages will be clear from the following detailed description, examples and appended claims.

All percentages, ratios and proportions herein are on a weight basis unless otherwise indicated. All documents cited herein are hereby incorporated by reference.

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1 A-C depict the DNA and amino acid sequence for *Bacillus amyloliquefaciens* subtilisin and a partial restriction map of this gene.

Fig. 2 depicts the conserved amino acid residues among subtilisins from *Bacillus amyloliquefaciens* (BPN') and *Bacillus lentus* (wild-type).

Figs. 3A and 3B depict the amino acid sequence of four subtilisins. The top line represents the amino acid sequence of subtilisin from *Bacillus amyloliquefaciens* subtilisin (also sometimes referred to as subtilisin BPN'). The second line depicts the amino acid sequence of subtilisin from *Bacillus subtilis*. The third line depicts the amino acid sequence of subtilisin from *B. licheniformis*. The fourth line depicts the amino acid sequence of subtilisin from *Bacillus lentus* (also referred to as subtilisin 309 in PCT WO89/06276). The symbol * denotes the absence of specific amino acid residues as compared to subtilisin BPN'.

DETAILED DESCRIPTION OF THE INVENTION

I. Proteases - Proteases are carbonyl hydrolases which generally act to cleave peptide bonds of proteins or peptides. As used herein, "protease" means a naturally occurring protease or recombinant protease. Naturally-occurring proteases include α -aminoacylpeptide hydrolase, peptidylamino acid hydrolase, acylamino hydrolase, serine carboxypeptidase, metallocarboxypeptidase, thiol proteinase, carboxylproteinase and metalloproteinase. Serine, metallo, thiol and acid protease are included, as well as endo and exo-proteases.

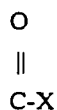
The present invention includes protease enzymes which are non-naturally occurring carbonyl hydrolase variants (protease variants) having a different proteolytic activity, stability, substrate specificity, pH profile and/or performance characteristic as compared to the precursor carbonyl hydrolase from which the amino acid sequence of the variant is derived. Specifically, such protease variants have an amino acid sequence not found in nature, which is derived by replacement of a plurality of amino acid residues of a precursor protease with different amino acids. The precursor protease may be a naturally-occurring protease or recombinant protease. As stated earlier, the protease variants are designed to have trypsin-like specificity and preferably also be bleach stable.

The protease variants useful herein encompass the substitution of any of the nineteen naturally occurring L-amino acids at the designated amino acid residue positions.

Such substitutions can be made in any precursor subtilisin (procaryotic, eucaryotic, mammalian, etc.). Throughout this application reference is made to various amino acids by way of common one- and three-letter codes. Such codes are identified in Dale, M.W. (1989), Molecular Genetics of Bacteria, John Wiley & Sons, Ltd., Appendix B.

The protease variants useful herein are preferably derived from a *Bacillus* subtilisin. More preferably, the protease variants are derived from *Bacillus lentus* subtilisin and/or subtilisin 309.

Carbonyl Hydrolases - Carbonyl hydrolases are protease enzymes which hydrolyze compounds containing



bonds in which X is oxygen or nitrogen. They include naturally-occurring carbonyl hydrolases and recombinant carbonyl hydrolases. Naturally-occurring carbonyl hydrolases principally include hydrolases, e.g., peptide hydrolases such as subtilisins or metalloproteases. Peptide hydrolases include α -aminoacylpeptide hydrolase, peptidylamino acid hydrolase, acylamino hydrolase, serine carboxypeptidase, metallo-carboxypeptidase, thiol proteinase, carboxylproteinase and metalloproteinase. Serine, metallo, thiol and acid protease's are included, as well as endo and exo-proteases.

Subtilisins - Subtilisins are bacterial or fungal proteases which generally act to cleave peptide bonds of proteins or peptides. As used herein, "subtilisin" means a naturally-occurring subtilisin or a recombinant subtilisin. A series of naturally-occurring subtilisins is known to be produced and often secreted by various microbial species. Amino acid sequences of the members of this series are not entirely homologous. However, the subtilisins in this series exhibit the same or similar type of proteolytic activity. This class of serine proteases share a common amino acid sequence defining a catalytic triad which distinguishes them from the chymotrypsin related class of serine proteases. The subtilisins and chymotrypsin related serine proteases both have a catalytic triad comprising aspartate, histidine and serine. In the subtilisin related proteases the relative order of these amino acids, reading from amino to carboxy terminus, is aspartate-histidine-serine. In the chymotrypsin related proteases, the relative order, however, is histidine-aspartate-serine. Thus, subtilisin herein refers to a serine protease having the catalytic triad of subtilisin related proteases. Examples include, but are not limited to, the subtilisins identified in Fig. 3 herein. Generally, and for purposes of the present invention, numbering of the amino acids in proteases corresponds to the numbers assigned to the mature *Bacillus amyloliquefaciens* subtilisin sequence presented in Fig. 1.

Protease Variants - A "protease variant" has an amino acid sequence which is derived from the amino acid sequence of a "precursor protease." The precursor proteases include naturally-occurring proteases and recombinant proteases. The amino acid sequence of the protease variant is "derived" from the precursor protease amino acid sequence by substitution, deletion or insertion of one or more amino acids of the precursor amino acid sequence. Such modification is of the "precursor DNA sequence" which encodes the amino acid sequence of the precursor protease rather than manipulation of the precursor protease enzyme *per se*. Suitable methods for such manipulation of the precursor DNA sequence include methods disclosed herein, as well as methods known to those skilled in the art (see, for example, EP 0 328 299, WO 89/06279 and the U.S. patents and applications already referenced herein).

In a preferred embodiment, the protease variants which are protease enzymes useful in the present invention cleaning compositions comprise protease variants including a substitution of an amino acid residue with another naturally occurring amino acid residue at an amino acid residue position corresponding to position 103 of *Bacillus amyloliquefaciens* subtilisin in combination with a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 1, 3, 4, 8, 9, 10, 12, 13, 16, 17, 18, 19, 20, 21, 22, 24, 27, 33, 37, 38, 42, 43, 48, 55, 57, 58, 61, 62, 68, 72, 75, 76, 77, 78, 79, 86, 87, 89, 97, 98, 99, 101, 102, 104, 106, 107, 109, 111, 114, 116, 117, 119, 121, 123, 126, 128, 130, 131, 133, 134, 137, 140, 141, 142, 146, 147, 158, 159, 160, 166, 167, 170, 173, 174, 177, 181, 182, 183, 184, 185, 188, 192, 194, 198, 203, 204, 205, 206, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 222, 224, 227, 228, 230, 232, 236, 237, 238, 240, 242, 243, 244, 245, 246, 247, 248, 249, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 265, 268, 269, 270, 271, 272, 274 and 275 of *Bacillus amyloliquefaciens* subtilisin; wherein when said protease variant includes a substitution of amino acid residues at positions corresponding to positions 103 and 76, there is also a substitution of an amino acid residue at one or more amino acid residue positions other than amino acid residue positions corresponding to positions 27, 99, 101, 104, 107, 109, 123, 128, 166, 204, 206, 210, 216, 217, 218, 222, 260, 265 or 274 of *Bacillus amyloliquefaciens* subtilisin; and one or more cleaning adjunct materials.

While any combination of the above listed amino acid substitutions may be employed, the preferred protease variant enzymes useful for the present invention comprise the substitution, deletion or insertion of amino acid residues in the following combinations:

- (1) a protease variant including substitutions of the amino acid residues at position 103 and at one or more of the following positions 236 and 245;

[illegible]

[illegible]

[illegible]

| | | | | | | | | | | | | |
|----|-----|-----|-----|-----|-----|-----|-----|--|--|--|--|--|
| 4 | 76 | 103 | 104 | 159 | 217 | 251 | | | | | | |
| 4 | 76 | 103 | 104 | 159 | 217 | 252 | | | | | | |
| 76 | 77 | 103 | 104 | 133 | 185 | 251 | | | | | | |
| 76 | 103 | 104 | 159 | 206 | 244 | | | | | | | |
| 4 | 76 | 103 | 104 | 188 | | | | | | | | |
| 4 | 76 | 103 | 104 | 158 | | | | | | | | |
| 76 | 77 | 103 | 104 | 185 | | | | | | | | |
| 76 | 103 | 104 | 206 | 251 | | | | | | | | |
| 48 | 76 | 103 | 104 | 111 | 159 | | | | | | | |
| 68 | 76 | 103 | 104 | 159 | 236 | | | | | | | |
| 42 | 76 | 103 | 104 | 159 | | | | | | | | |
| 12 | 62 | 76 | 103 | 104 | 159 | | | | | | | |
| 42 | 76 | 103 | 104 | 159 | | | | | | | | |
| 76 | 103 | 104 | 146 | 159 | | | | | | | | |
| 76 | 103 | 104 | 159 | 238 | | | | | | | | |
| 76 | 103 | 104 | 159 | 224 | | | | | | | | |
| 76 | 103 | 104 | 212 | 268 | 271 | | | | | | | |
| 76 | 89 | 103 | 104 | | | | | | | | | |
| 76 | 87 | 103 | 104 | 212 | 271 | | | | | | | |
| 76 | 103 | 104 | 212 | 245 | 271 | | | | | | | |
| 76 | 103 | 104 | 134 | 141 | 212 | 271 | | | | | | |
| 76 | 103 | 104 | 212 | 236 | 243 | 271 | | | | | | |
| 76 | 103 | 104 | 109 | 245 | | | | | | | | |
| 76 | 103 | 104 | 109 | 210 | | | | | | | | |
| 20 | 62 | 76 | 103 | 104 | | | | | | | | |
| 68 | 76 | 103 | 104 | 236 | | | | | | | | |
| 68 | 76 | 103 | 104 | 159 | 236 | 271 | | | | | | |
| 68 | 76 | 103 | 104 | 159 | 236 | 245 | | | | | | |
| 68 | 76 | 103 | 104 | 159 | 217 | 236 | 271 | | | | | |
| 17 | 68 | 76 | 103 | 104 | | | | | | | | |
| 68 | 76 | 103 | 104 | | | | | | | | | |
| 68 | 76 | 103 | 104 | 159 | 236 | | | | | | | |

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|----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|--|--|
| 68 | 75 | 76 | 103 | 104 | 159 | 236 | | | | | | |
| 68 | 76 | 76 | 103 | 114 | 121 | 159 | 236 | 245 | | | | |
| 12 | 68 | 76 | 103 | 104 | 159 | 236 | | | | | | |
| 68 | 76 | 103 | 104 | 159 | 209 | 236 | 253 | | | | | |
| 68 | 76 | 103 | 104 | 117 | 159 | 184 | 236 | | | | | |
| 68 | 76 | 103 | 104 | 159 | 236 | 243 | | | | | | |
| 68 | 76 | 103 | 104 | 159 | 236 | 245 | | | | | | |
| 68 | 76 | 103 | 104 | 142 | 159 | | | | | | | |
| 68 | 76 | 103 | 104 | 123 | 159 | 236 | 249 | | | | | |
| 68 | 76 | 103 | 104 | 159 | 236 | 249 | | | | | | |
| 76 | 103 | 104 | 222 | 245 | | | | | | | | |
| 12 | 76 | 103 | 104 | 222 | 249 | | | | | | | |
| 76 | 103 | 104 | 173 | 222 | | | | | | | | |
| 76 | 103 | 104 | 222 | 263 | | | | | | | | |
| 21 | 76 | 103 | 104 | 222 | 237 | 263 | | | | | | |
| 76 | 103 | 104 | 109 | 222 | | | | | | | | |
| 76 | 103 | 104 | 109 | 222 | 271 | | | | | | | |
| 61 | 76 | 103 | 104 | 222 | | | | | | | | |
| 76 | 103 | 104 | 137 | 222 | | | | | | | | |
| 76 | 103 | 104 | 109 | 222 | 248 | | | | | | | |
| 76 | 103 | 104 | 222 | 249 | | | | | | | | |
| 68 | 76 | 103 | 104 | 159 | 236 | 245 | 261 | | | | | |
| 68 | 76 | 103 | 104 | 141 | 159 | 236 | 245 | 255 | | | | |
| 68 | 76 | 103 | 104 | 159 | 236 | 245 | 247 | | | | | |
| 68 | 76 | 103 | 104 | 159 | 174 | 204 | 236 | 245 | | | | |
| 68 | 76 | 103 | 104 | 159 | 204 | 236 | 245 | | | | | |
| 68 | 76 | 103 | 104 | 133 | 159 | 218 | 236 | 245 | | | | |
| 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | | | | | |
| 68 | 76 | 103 | 104 | 159 | 194 | 203 | 236 | 245 | | | | |
| 12 | 76 | 103 | 104 | 222 | 245 | | | | | | | |
| 76 | 103 | 104 | 232 | 245 | | | | | | | | |
| 24 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | | | | |

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|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|--|
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 252 | | | | | |
| 68 | 76 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 260 | | | |
| 12 | 76 | 103 | 104 | 222 | 244 | 245 | | | | | | |
| 12 | 76 | 103 | 222 | 210 | 245 | | | | | | | |
| 12 | 76 | 103 | 104 | 130 | 222 | 245 | | | | | | |
| 22 | 68 | 76 | 103 | 104 | | | | | | | | |
| 68 | 76 | 103 | 104 | 184 | | | | | | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | | | | | | |
| 68 | 103 | 104 | 140 | 159 | 232 | 236 | 245 | 252 | | | | |
| 43 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 252 | | | | |
| 43 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | | | | | |
| 43 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 252 | | | | |
| 68 | 87 | 103 | 104 | 159 | 232 | 236 | 245 | 252 | 275 | | | |
| 12 | 76 | 103 | 104 | 130 | 222 | 245 | 248 | 262 | | | | |
| 12 | 76 | 103 | 104 | 130 | 215 | 222 | 245 | | | | | |
| 12 | 76 | 103 | 104 | 130 | 222 | 227 | 245 | 262 | | | | |
| 12 | 76 | 103 | 104 | 130 | 222 | 245 | 261 | | | | | |
| 76 | 103 | 104 | 130 | 222 | 245 | | | | | | | |
| 12 | 76 | 103 | 104 | 130 | 218 | 222 | 245 | 262 | 269 | | | |
| 12 | 57 | 76 | 103 | 104 | 130 | 222 | 245 | 251 | | | | |
| 12 | 76 | 103 | 104 | 130 | 170 | 185 | 222 | 243 | 245 | | | |
| 12 | 76 | 103 | 104 | 130 | 222 | 245 | 268 | | | | | |
| 12 | 76 | 103 | 104 | 130 | 222 | 210 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 257 | | | | | |
| 68 | 103 | 104 | 116 | 159 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | | | | | |
| 10 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 203 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 237 | 245 | | | | | |
| 68 | 76 | 79 | 103 | 104 | 159 | 232 | 236 | 245 | | | | |
| 68 | 103 | 104 | 159 | 183 | 232 | 236 | 245 | | | | | |

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|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|--|
| 68 | 103 | 104 | 159 | 174 | 206 | 232 | 236 | 245 | | | | |
| 68 | 103 | 104 | 159 | 188 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 230 | 232 | 236 | 245 | | | | | |
| 68 | 98 | 103 | 104 | 159 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 215 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | | | | | |
| 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | | | | | |
| 68 | 76 | 103 | 104 | 159 | 210 | 232 | 236 | 245 | | | | |
| 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 257 | | | | |
| 76 | 103 | 104 | 232 | 236 | 245 | 257 | | | | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 257 | 275 | | | | |
| 76 | 103 | 104 | 257 | 275 | | | | | | | | |
| 68 | 103 | 104 | 159 | 224 | 232 | 236 | 245 | 257 | | | | |
| 76 | 103 | 104 | 159 | 232 | 236 | 245 | 257 | | | | | |
| 68 | 76 | 103 | 104 | 159 | 209 | 232 | 236 | 245 | | | | |
| 68 | 76 | 103 | 104 | 159 | 211 | 232 | 236 | 245 | | | | |
| 12 | 68 | 76 | 103 | 104 | 159 | 214 | 232 | 236 | 245 | | | |
| 68 | 76 | 103 | 104 | 159 | 215 | 232 | 236 | 245 | | | | |
| 12 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | | | | |
| 20 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 259 | | | |
| 68 | 87 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 260 | | | |
| 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 261 | | | | |
| 76 | 103 | 104 | 232 | 236 | 242 | 245 | | | | | | |
| 68 | 76 | 103 | 104 | 159 | 210 | 232 | 236 | 245 | | | | |
| 12 | 48 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | | | |
| 76 | 103 | 104 | 232 | 236 | 245 | | | | | | | |
| 76 | 103 | 104 | 159 | 192 | 232 | 236 | 245 | | | | | |
| 76 | 103 | 104 | 147 | 159 | 232 | 236 | 245 | 248 | 251 | | | |
| 12 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 272 | | | |
| 68 | 76 | 103 | 104 | 159 | 183 | 206 | 232 | 236 | 245 | | | |
| 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 256 | | | | |
| 68 | 76 | 103 | 104 | 159 | 206 | 232 | 236 | 245 | | | | |

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|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|
| 27 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | | | | |
| 68 | 76 | 103 | 104 | 116 | 159 | 170 | 185 | 232 | 236 | 245 | | |
| 61 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 43 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 99 | 159 | 184 | 232 | 236 | 245 | 248 | 252 | | |
| 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | | |
| 68 | 103 | 104 | 159 | 209 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 109 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 20 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 209 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 261 | | | |
| 68 | 103 | 104 | 159 | 185 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 210 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 185 | 210 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 213 | 232 | 236 | 245 | 248 | 252 | | | | |
| 68 | 103 | 104 | 159 | 215 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 216 | 232 | 236 | 245 | 248 | 252 | | | |
| 20 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 173 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 251 | 252 | | | |
| 68 | 103 | 104 | 159 | 206 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 55 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 255 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 256 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 260 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 257 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 258 | | | |
| 8 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 269 | | |

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|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| 68 | 103 | 104 | 116 | 159 | 232 | 236 | 245 | 248 | 252 | 260 | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 261 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 261 | | | |
| 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 232 | 236 | 245 | 248 | 252 | | | | | |
| 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 18 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 68 | 76 | 101 | 103 | 104 | 159 | 213 | 218 | 232 | 236 | 245 | 260 | |
| 68 | 103 | 104 | 159 | 228 | 232 | 236 | 245 | 248 | 252 | | | |
| 33 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 76 | 89 | 103 | 104 | 159 | 210 | 213 | 232 | 236 | 245 | 260 | |
| 61 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | |
| 103 | 104 | 159 | 205 | 210 | 232 | 236 | 245 | | | | | |
| 61 | 68 | 103 | 104 | 130 | 159 | 232 | 236 | 245 | 248 | 252 | | |
| 61 | 68 | 103 | 104 | 133 | 137 | 159 | 232 | 236 | 245 | 248 | 252 | |
| 61 | 103 | 104 | 133 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 68 | 103 | 104 | 159 | 218 | 232 | 236 | 245 | 248 | 252 | | | |
| 61 | 68 | 103 | 104 | 159 | 160 | 232 | 236 | 245 | 248 | 252 | | |
| 3 | 61 | 68 | 76 | 103 | 104 | 232 | 236 | 245 | 248 | 252 | | |
| 61 | 68 | 103 | 104 | 159 | 167 | 232 | 236 | 245 | 248 | 252 | | |
| 97 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 98 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 99 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 101 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 102 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 103 | 104 | 106 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 103 | 104 | 109 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 261 | | | | |
| 62 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |

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|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|
| 103 | 104 | 159 | 184 | 232 | 236 | 245 | 248 | 252 | | | | |
| 103 | 104 | 159 | 166 | 232 | 236 | 245 | 248 | 252 | | | | |
| 103 | 104 | 159 | 217 | 232 | 236 | 245 | 248 | 252 | | | | |
| 20 | 62 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | |
| 62 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | | |
| 103 | 104 | 159 | 206 | 217 | 232 | 236 | 245 | 248 | 252 | | | |
| 62 | 103 | 104 | 159 | 206 | 232 | 236 | 245 | 248 | 252 | | | |
| 103 | 104 | 130 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 103 | 104 | 131 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 27 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 38 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 38 | 76 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 260 | | | |
| 68 | 76 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 260 | 271 | | |
| 68 | 76 | 103 | 104 | 159 | 209 | 213 | 232 | 236 | 245 | 260 | | |
| 68 | 76 | 103 | 104 | 159 | 210 | 213 | 232 | 236 | 245 | 260 | | |
| 68 | 76 | 103 | 104 | 159 | 205 | 213 | 232 | 236 | 245 | 260 | | |
| 68 | 76 | 103 | 104 | 159 | 210 | 232 | 236 | 245 | 260 | | | |
| 68 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 260 | | | | |
| 76 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 260 | | | | |
| 68 | 103 | 104 | 159 | 209 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 210 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 230 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 126 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 205 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 210 | 232 | 236 | 245 | | | | | |
| 103 | 104 | 159 | 230 | 236 | 245 | | | | | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 260 | | | | | |
| 103 | 104 | 159 | 232 | 236 | 245 | | | | | | | |
| 68 | 103 | 104 | 159 | 174 | 232 | 236 | 245 | 257 | | | | |
| 68 | 103 | 104 | 159 | 194 | 232 | 236 | 245 | 257 | | | | |
| 68 | 103 | 104 | 159 | 209 | 232 | 236 | 245 | 257 | | | | |
| 103 | 104 | 159 | 232 | 236 | 245 | 257 | | | | | | |

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|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|
| 68 | 76 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 260 | 261 | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 257 | 261 | | | | |
| 103 | 104 | 159 | 213 | 232 | 236 | 245 | 260 | | | | | |
| 103 | 104 | 159 | 210 | 232 | 236 | 245 | 248 | 252 | | | | |
| 103 | 104 | 159 | 209 | 232 | 236 | 245 | 257 | | | | | |
| 68 | 76 | 103 | 104 | 159 | 210 | 213 | 232 | 236 | 245 | 260 | | |
| 12 | 103 | 104 | 159 | 209 | 213 | 232 | 236 | 245 | 260 | | | |
| 103 | 104 | 209 | 232 | 236 | 245 | 257 | | | | | | |
| 103 | 104 | 159 | 205 | 210 | 213 | 232 | 236 | 245 | 260 | | | |
| 103 | 104 | 159 | 205 | 209 | 232 | 236 | 245 | 260 | | | | |
| 68 | 103 | 104 | 159 | 205 | 209 | 210 | 232 | 236 | 245 | | | |
| 103 | 104 | 159 | 205 | 209 | 210 | 232 | 236 | 245 | 257 | | | |
| 103 | 104 | 159 | 205 | 209 | 232 | 236 | 245 | 257 | | | | |
| 68 | 103 | 104 | 159 | 205 | 209 | 210 | 232 | 236 | 245 | 260 | | |
| 103 | 104 | 159 | 205 | 209 | 210 | 232 | 236 | 245 | | | | |
| 103 | 104 | 159 | 209 | 210 | 232 | 236 | 245 | | | | | |
| 103 | 104 | 159 | 205 | 210 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 128 | 159 | 232 | 236 | 245 | | | | | |
| 48 | 103 | 104 | 159 | 230 | 236 | 245 | | | | | | |
| 48 | 68 | 103 | 104 | 159 | 209 | 232 | 236 | 245 | | | | |
| 48 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 48 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 257 | 261 | | | |
| 102 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | | |
| 12 | 102 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | |
| 101 | 102 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | |
| 98 | 102 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | |
| 102 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | | |
| 103 | 104 | 131 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 103 | 104 | 159 | 184 | 232 | 236 | 245 | 248 | 252 | | | | |
| 103 | 104 | 159 | 232 | 236 | 244 | 245 | 248 | 252 | | | | |
| 62 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | 256 | | |
| 12 | 62 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | |

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|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 101 | 103 | 104 | 159 | 185 | 232 | 236 | 245 | 248 | 252 | | | |
| 101 | 103 | 104 | 159 | 206 | 232 | 236 | 245 | 248 | 252 | | | |
| 101 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | | |
| 98 | 102 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 101 | 102 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 98 | 102 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | |
| 98 | 102 | 103 | 104 | 159 | 212 | 232 | 236 | 248 | 252 | | | |
| 62 | 103 | 104 | 109 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | |
| 62 | 103 | 104 | 159 | 212 | 213 | 232 | 236 | 245 | 248 | 252 | | |
| 62 | 101 | 103 | 104 | 159 | 212 | 213 | 232 | 236 | 245 | 248 | 252 | |
| 103 | 104 | 159 | 232 | 245 | 248 | 252 | | | | | | |
| 103 | 104 | 159 | 230 | 245 | | | | | | | | |
| 62 | 103 | 104 | 130 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | |
| 101 | 103 | 104 | 130 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 101 | 103 | 104 | 128 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 62 | 101 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | |
| 62 | 103 | 104 | 128 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | |
| 62 | 103 | 104 | 128 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | |
| 101 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 260 | | | |
| 101 | 103 | 104 | 131 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 98 | 101 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 99 | 101 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 101 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | | |
| 76 | 103 | 104 | 167 | 170 | 194 | | | | | | | |
| 101 | 103 | 104 | 159 | 209 | 232 | 236 | 245 | 248 | 252 | | | |
| 101 | 103 | 104 | 159 | 210 | 232 | 236 | 245 | 248 | 252 | | | |
| 101 | 103 | 104 | 159 | 205 | 232 | 236 | 245 | 248 | 252 | | | |
| 101 | 103 | 104 | 159 | 230 | 236 | 245 | | | | | | |
| 101 | 103 | 104 | 159 | 194 | 232 | 236 | 245 | 248 | 252 | | | |
| 76 | 101 | 103 | 104 | 159 | 194 | 232 | 236 | 245 | 248 | 252 | | |
| 101 | 103 | 104 | 159 | 230 | 232 | 236 | 245 | 248 | 252 | | | |
| 62 | 103 | 104 | 159 | 185 | 206 | 213 | 232 | 236 | 245 | 248 | 252 | 271 |

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|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| S103A | V104I | G159D | A232V | Q236H | V244A | Q245R | N248D | N252K | | | | |
| N62D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | S256R | | |
| Q12R | N62D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| S101G | S103A | V104I | G159D | N185D | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | G159D | Q206E | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | G159D | T213Q | A232V | Q236H | Q245R | N248D | N252K | | | |
| A98L | G102A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | G102A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| A98L | G102A | S103A | V104I | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | | |
| A98L | G102A | S103A | V104I | G159D | S212G | A232V | Q236H | N248D | N252K | | | |
| N62D | S103A | V104I | Q109R | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| N62D | S103A | V104I | G159D | S212G | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| N62D | S101G | S103A | V104I | G159D | S212G | T213R | A232V | Q236H | Q245R | N248D | N252K | |
| S103A | V104I | G159D | A232V | Q245R | N248D | N252K | | | | | | |
| S103A | V104I | G159D | A230V | Q245R | | | | | | | | |
| N62D | S103A | V104I | S130G | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| S101G | S103A | V104I | S130G | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | S128G | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | S128L | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| N62D | S101G | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| N62D | S103A | V104I | S128G | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| N62D | S103A | V104I | S128L | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| S101G | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | T260A | | | |
| S101G | S103A | V104I | PI31V | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| A98V | S101G | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| S99G | S101G | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | | | |
| | | | | | | | | | | | | |
| S101G | S103A | V104I | G159D | Y209W | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | G159D | P210I | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | G159D | V205I | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | G159D | A230V | Q236H | Q245R | | | | | | |
| S101G | S103A | V104I | G159D | A194P | A232V | Q236H | Q245R | N248D | N252K | | | |
| N76D | S101G | S103A | V104I | G159D | A194P | A232V | Q236H | Q245R | N248D | N252K | | |
| S101G | S103A | V104I | G159D | A230V | A232V | Q236H | Q245R | N248D | N252K | | | |
| N62D | S103A | V104I | G159D | N185D | Q206E | T213R | A232V | Q236H | Q245R | N248D | N252K | E271Q |

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|-------|-------|-------|-------|-------|-------|-------|--|--|--|--|--|--|--|
| S103A | V104I | A228T | | | | | | | | | | | |
| N76D | S103A | V104I | Q182R | I198V | | | | | | | | | |
| L21M | N76D | S103A | V104I | Q182R | | | | | | | | | |
| N76D | S103A | V104I | M119I | Q137R | | | | | | | | | |
| N76D | S103A | V104I | Q137R | N248S | | | | | | | | | |
| A13T | N76D | S103A | V104I | Q206R | | | | | | | | | |
| N76D | S103A | V104I | Q206R | | | | | | | | | | |
| N76D | S103A | V104I | S212P | G258R | | | | | | | | | |
| T58S | N76D | S103A | V104I | E271G | | | | | | | | | |
| N76D | S103A | V104I | Q206E | N261D | | | | | | | | | |
| V4E | N76D | S103A | V104I | Q206E | | | | | | | | | |
| N76D | N77D | S103A | V104I | Q206E | | | | | | | | | |
| N76D | S103A | V104I | A158E | | | | | | | | | | |
| N76D | S103A | V104I | Q206E | | | | | | | | | | |
| V4E | N76D | S103A | V104I | G159D | L217E | K251Q | | | | | | | |
| V4E | N76D | S103A | V104I | G159D | L217E | N252D | | | | | | | |
| N76D | N77D | S103A | V104I | A133T | N185D | K251T | | | | | | | |
| N76D | S103A | V104I | G159D | Q206E | V244A | | | | | | | | |
| V4E | N76D | S103A | V104I | S188E | | | | | | | | | |
| V4E | N76D | S103A | V104I | A158E | | | | | | | | | |
| N76D | N77D | S103A | V104I | N185D | | | | | | | | | |
| N76D | S103A | V104I | Q206E | K251T | | | | | | | | | |
| A48T | N76D | S103A | V104I | L111M | G159D | | | | | | | | |
| V68A | N76D | S103A | V104I | G159D | Q236H | | | | | | | | |
| L42V | N76D | S103A | V104I | G159D | | | | | | | | | |
| Q12H | N62H | N76D | S103A | V104I | G159D | | | | | | | | |
| L42I | N76D | S103A | V104I | G159D | | | | | | | | | |
| N76D | S103A | V104I | G146S | G159D | | | | | | | | | |
| N76D | S103A | V104I | G159D | N238S | | | | | | | | | |
| N76D | S103A | V104I | G159D | T224A | | | | | | | | | |
| N76D | S103A | V104I | S212P | V268F | E271V | | | | | | | | |
| N76D | E89A | S103A | V104I | | | | | | | | | | |
| N76D | S87R | S103A | V104I | S212P | E271V | | | | | | | | |
| N76D | S103A | V104I | S212P | Q245L | E271V | | | | | | | | |
| N76D | S103A | V104I | T134S | S141N | S212P | E271V | | | | | | | |
| N76D | S103A | V104I | S212P | Q236L | N243S | E271V | | | | | | | |

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|------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|--|--|
| N76D | S103A | V104I | Q109R | Q245R | | | | | | | | |
| N76D | S103A | V104I | Q109R | P210L | | | | | | | | |
| G20V | N62S | N76D | S103A | V104I | | | | | | | | |
| V68A | N76D | S103A | V104I | Q236H | | | | | | | | |
| V68A | N76D | S103A | V104I | G159D | Q236H | E271V | | | | | | |
| V68A | N76D | S103A | V104I | G159D | Q236H | Q245R | | | | | | |
| V68A | N76D | S103A | V104I | G159D | L217I | Q236H | E271V | | | | | |
| H17Q | V68A | N76D | S103A | V104I | | | | | | | | |
| V68A | N76D | S103A | V104I | | | | | | | | | |
| V68A | N76D | S103A | V104I | G159D | Q236R | | | | | | | |
| V68A | L75R | N76D | S103A | V104I | G159D | Q236H | | | | | | |
| V68A | N76D | N76D | S103A | A114V | V121I | G159D | Q236H | Q245R | | | | |
| Q12R | V68A | N76D | S103A | V104I | G159D | Q236H | | | | | | |
| V68A | N76D | S103A | V104I | G159D | Y209S | Q236H | T253K | | | | | |
| V68A | N76D | S103A | V104I | N117K | G159D | N184S | Q236H | | | | | |
| V68A | N76D | S103A | V104I | G159D | Q236H | N243I | | | | | | |
| V68A | N76D | S103A | V104I | G159D | Q236H | Q245L | | | | | | |
| V68A | N76D | S103A | V104I | A142V | G159D | | | | | | | |
| V68A | N76D | S103A | V104I | N123S | G159D | Q236H | H249Y | | | | | |
| V68A | N76D | S103A | V104I | G159D | Q236H | H249Q | | | | | | |
| N76D | S103A | V104I | M222S | Q245R | | | | | | | | |
| Q12R | N76D | S103A | V104I | M222S | H249R | | | | | | | |
| N76D | S103A | V104I | N173R | M222S | | | | | | | | |
| N76D | S103A | V104I | M222S | Y263F | | | | | | | | |
| L21M | N76D | S103A | V104I | M222S | K237R | Y263F | | | | | | |
| N76D | S103A | V104I | Q109R | M222S | | | | | | | | |
| N76D | S103A | V104I | Q109R | M222S | E271D | | | | | | | |
| G61R | N76D | S103A | V104I | M222S | | | | | | | | |
| N76D | S103A | V104I | Q137R | M222S | | | | | | | | |
| N76D | S103A | V104I | Q109R | M222S | N248S | | | | | | | |
| N76D | S103A | V104I | M222S | H249R | | | | | | | | |
| V68A | N76D | S103A | V104I | G159D | Q236H | Q245R | N261D | | | | | |
| V68A | N76D | S103A | V104I | S141N | G159D | Q236H | Q245R | T255S | | | | |
| V68A | N76D | S103A | V104I | G159D | Q236H | Q245R | R247H | | | | | |
| V68A | N76D | S103A | V104I | G159D | A174V | N204D | Q236H | Q245R | | | | |
| V68A | N76D | S103A | V104I | G159D | N204D | Q236H | Q245R | | | | | |

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|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|--|
| V68A | N76D | S103A | V104I | A133V | G159D | N218D | Q236H | Q245R | | | | |
| V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | | |
| V68A | N76D | S103A | V104I | G159D | A194I | V203A | Q236H | Q245R | | | | |
| Q12R | N76D | S103A | V104I | M222S | Q245R | | | | | | | |
| N76D | S103A | V104I | A232V | Q245R | | | | | | | | |
| S24T | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N252K | | | | | |
| V68A | N76D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | T260A | | | |
| Q12R | N76D | S103A | I104T | M222S | V244I | Q245R | | | | | | |
| Q12R | N76D | S103A | M222S | P210T | Q245R | | | | | | | |
| Q12R | N76D | S103A | I104T | S130T | M222S | Q245R | | | | | | |
| T22K | V68A | N76D | S103A | V104I | | | | | | | | |
| V68A | N76D | S103A | V104I | N184D | | | | | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | | | |
| V68A | S103A | V104I | N140D | G159D | A232V | Q236H | Q245R | N252K | | | | |
| N43S | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N252K | | | | |
| N43K | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | | |
| N43D | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N252K | | | | |
| V68A | S87G | S103A | V104I | G159D | A232V | Q236H | Q245R | N252K | R275S | | | |
| Q12R | N76D | S103A | I104T | S130T | M222S | Q245R | N248S | L262M | | | | |
| Q12R | N76D | S103A | I104T | S130T | A215V | M222S | Q245R | | | | | |
| Q12R | N76D | S103A | I104T | S130T | M222S | V227A | Q245R | L262S | | | | |
| Q12R | N76D | S103A | I104T | S130T | A215T | M222S | Q245R | | | | | |
| Q12R | N76D | S103A | I104T | S130T | M222S | Q245R | N261D | | | | | |
| N76D | S103A | I104T | S130T | M222S | Q245R | | | | | | | |
| Q12R | N76D | S103A | I104T | S130T | N218D | M222S | Q245R | L262S | N269D | | | |
| Q12R | S57P | N76D | S103A | I104T | S130T | M222S | Q245R | K251Q | | | | |
| Q12R | N76D | S103A | I104T | S130T | R170S | N185D | M222S | N243D | Q245R | | | |
| Q12R | N76D | S103A | I104T | S130T | M222S | Q245R | V268A | | | | | |
| Q12R | N76D | S103A | I104T | S130T | M222S | P210S | Q245R | | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | | | | | |
| V68A | S103A | V104I | N116D | G159D | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | | | | | |
| R10C | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | V203E | A232V | Q236H | Q245R | | | | | |

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|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|--|--|
| V68A | S103A | V104I | G159D | A232V | Q236H | K237E | Q245R | | | | | | |
| V68A | N76D | I79N | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | N183D | A232V | Q236H | Q245R | | | | | | |
| V68A | S103A | V104I | G159D | A174V | Q206L | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | S188C | A232V | Q236H | Q245R | | | | | | |
| V68A | S103A | V104I | G159D | A230T | A232V | Q236H | Q245R | | | | | | |
| V68A | A98T | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | | | |
| V68A | S103A | V104I | G159D | A215T | A232V | Q236H | Q245R | | | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248S | | | | | | |
| V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | | | |
| V68A | N76D | S103A | V104I | G159D | P210R | A232V | Q236H | Q245R | | | | | |
| V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | | | | | |
| N76D | S103A | V104I | A232V | Q236H | Q245R | L257V | | | | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | R275H | | | | | |
| N76D | S103A | V104I | L257V | R275H | | | | | | | | | |
| V68A | S103A | V104I | G159D | T224A | A232V | Q236H | Q245R | L257V | | | | | |
| N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | | | | | | |
| V68A | N76D | S103A | V104I | G159D | Y209W | A232V | Q236H | Q245R | | | | | |
| V68A | N76D | S103A | V104I | G159D | G211R | A232V | Q236H | Q245R | | | | | |
| V68A | N76D | S103A | V104I | G159D | G211V | A232V | Q236H | Q245R | | | | | |
| Q12R | V68A | N76D | S103A | V104I | G159D | Y214L | A232V | Q236H | Q245R | | | | |
| V68A | N76D | S103A | V104I | G159D | A215R | A232V | Q236H | Q245R | | | | | |
| Q12R | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | | |
| G20R | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | S259G | | | | |
| V68A | S87R | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | T260V | | | | |
| V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | N261G | | | | | |
| V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | N261W | | | | | |
| N76D | S103A | V104I | A232V | Q236H | S242P | Q245R | | | | | | | |
| V68A | N76D | S103A | V104I | G159D | P210L | A232V | Q236H | Q245R | | | | | |
| Q12R | A48V | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | |
| N76D | S103A | V104I | A232V | Q236H | Q245R | | | | | | | | |
| N76D | S103A | V104I | G159D | Y192F | A232V | Q236H | Q245R | | | | | | |
| N76D | S103A | V104I | V147I | G159D | A232V | Q236H | Q245R | N248S | K251R | | | | |
| Q12R | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | A272S | | | | |
| V68A | N76D | S103A | V104I | G159D | N183K | Q206L | A232V | Q236H | Q245R | | | | |
| V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | S256R | | | | | |

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| V68A | N76D | S103A | V104I | G159D | Q206R | A232V | Q236H | Q245R | | | | |
| K27R | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | |
| V68A | N76D | S103A | V104I | N116T | G159D | R170S | N185S | A232V | Q236H | Q245R | | |
| G61E | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| N43D | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | S212P | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | S99N | G159D | N184D | A232V | Q236H | Q245R | N248D | N252K | | |
| S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | | |
| V68A | S103A | V104I | G159D | Y209W | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | Q109R | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| G20R | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | Y209F | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | N261D | | | |
| V68A | S103A | V104I | G159D | N185D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | P210R | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | P210T | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | P210S | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | N185D | P210L | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | P210L | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | S212A | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | S212E | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | T213E | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | T213S | A232V | Q236H | Q245R | N248D | N252K | | | | |
| V68A | A103V | V104I | G159D | T213E | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | T213G | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | A215V | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | A215R | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | S216T | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | S216V | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | S216C | A232V | Q236H | Q245R | N248D | N252K | | | |
| G20A | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | N173D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | K251V | N252K | | | |
| V68A | S103A | V104I | G159D | Q206R | A232V | Q236H | Q245R | N248D | N252K | | | |

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| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252F | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252L | | | | |
| P55S | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252F | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | T255V | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | S256N | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | S256E | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | S256R | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | T260R | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | L257R | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | G258D | | | |
| 18V | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | N269D | | |
| V68A | S103A | V104I | N116S | G159D | A232V | Q236H | Q245R | N248D | N252K | T260E | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | N261R | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | N261D | | | |
| V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | A232V | Q236H | Q245R | N248D | N252K | | | | | |
| S103A | V104I | G159D | A232S | Q236H | Q245R | N248D | N252K | | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236R | Q245R | N248D | N252K | | | | |
| N18S | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245V | N248D | N252K | | | | |
| V68A | N76D | S101T | S103A | V104I | G159D | T213R | N218S | A232V | Q236H | Q245R | T260A | |
| V68A | S103A | V104I | G159D | A228V | A232V | Q236H | Q245R | N248D | N252K | | | |
| T33S | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | N76D | E89D | S103A | V104I | G159D | P210L | T213R | A232V | Q236H | Q245R | T260A | |
| G61E | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | |
| S103A | V104I | G159D | V205I | P210I | A232V | Q236H | Q245R | | | | | |
| G61E | V68A | S103A | V104I | S130A | G159D | A232V | Q236H | Q245R | N248D | N252K | | |
| G61E | V68A | S103A | V104I | A133S | Q137R | G159D | A232V | Q236H | Q245R | N248D | N252K | |
| G61E | S103A | V104I | A133V | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248G | N252K | | | | |
| V68A | S103A | V104I | G159D | N218S | A232V | Q236H | Q245R | N248D | N252K | | | |
| G61E | V68A | S103A | V104I | G159D | S160V | A232V | Q236H | Q245R | N248D | N252K | | |
| S3L | G61E | V68A | N76D | S103A | V104I | A232V | Q236H | Q245R | N248D | N252K | | |
| G61E | V68A | S103A | V104I | G159D | S167F | A232V | Q236H | Q245R | N248D | N252K | | |
| G97E | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| A98D | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |

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| S99E | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S101E | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S101G | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| G102A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S103A | V104I | S106E | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S103A | V104I | Q109E | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | N261R | | | | |
| S103A | V104I | Q109R | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| N62D | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S103A | V104I | G159D | N184D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S103A | V104I | G159D | S166D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S103A | V104I | G159D | L217E | A232V | Q236H | Q245R | N248D | N252K | | | | |
| G20R | N62D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| N62D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | | |
| S103A | V104I | G159D | Q206R | L217E | A232V | Q236H | Q245R | N248D | N252K | | | |
| N62D | S103A | V104I | G159D | Q206R | A232V | Q236H | Q245R | N248D | N252K | | | |
| S103A | V104I | S130G | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S103A | V104I | P131V | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| K27N | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| T38G | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| T38A | N76D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | T260A | | | |
| V68A | N76D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | T260A | E271G | | |
| V68A | N76D | S103A | V104I | G159D | Y209W | T213R | A232V | Q236H | Q245R | T260A | | |
| V68A | N76D | S103A | V104I | G159D | P210I | T213R | A232V | Q236H | Q245R | T260A | | |
| V68A | N76D | S103A | V104I | G159D | V205I | T213R | A232V | Q236H | Q245R | T260A | | |
| V68A | N76D | S103A | V104I | G159D | P210I | A232V | Q236H | Q245R | T260A | | | |
| V68A | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | T260A | | | | |
| N76D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | T260A | | | | |
| V68A | S103A | V104I | G159D | Y209W | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | P210I | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | A230V | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | L126F | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | V205I | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | P210L | A232V | Q236H | Q245R | | | | | |
| S103A | V104I | G159D | A230V | Q236H | Q245R | | | | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | T260A | | | | | |

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| S103A | V104I | G159D | A232V | Q236H | Q245R | | | | | | | | |
| V68A | S103A | V104I | G159D | A174V | A232V | Q236H | Q245R | L257V | | | | | |
| V68A | S103A | V104I | G159D | A194S | A232V | Q236H | Q245R | L257V | | | | | |
| V68A | S103A | V104I | G159D | Y209W | A232V | Q236H | Q245R | L257V | | | | | |
| S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | | | | | | | |
| V68A | N76D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | T260A | N261W | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | N261W | | | | | |
| S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | T260A | | | | | | |
| S103A | V104I | G159D | P210I | A232V | Q236H | Q245R | N248D | N252K | | | | | |
| S103A | V104I | G159D | Y209W | A232V | Q236H | Q245R | L257V | | | | | | |
| V68A | N76D | S103A | V104I | G159D | P210L | T213R | A232V | Q236H | Q245R | T260A | | | |
| Q12R | S103A | V104I | G159D | Y209W | T213R | A232V | Q236H | Q245R | T260A | | | | |
| S103A | V104I | Y209W | A232V | Q236H | Q245R | L257V | | | | | | | |
| S103A | V104I | G159D | V205I | P210I | T213R | A232V | Q236H | Q245R | T260A | | | | |
| S103A | V104I | G159D | V205I | Y209W | A232V | Q236H | Q245R | T260A | | | | | |
| V68A | S103A | V104I | G159D | V205I | Y209W | P210I | A232V | Q236H | Q245R | | | | |
| S103A | V104I | G159D | V205I | Y209W | P210I | A232V | Q236H | Q245R | L257V | | | | |
| S103A | V104I | G159D | V205I | Y209W | A232V | Q236H | Q245R | L257V | | | | | |
| V68A | S103A | V104I | G159D | V205I | Y209W | P210I | A232V | Q236H | Q245R | T260A | | | |
| S103A | V104I | G159D | V205I | Y209W | P210I | A232V | Q236H | Q245R | | | | | |
| S103A | V104I | G159D | Y209W | P210I | A232V | Q236H | Q245R | | | | | | |
| S103A | V104I | G159D | V205I | P210I | A232V | Q236H | Q245R | | | | | | |
| V68A | S103A | V104I | S128L | G159D | A232V | Q236H | Q245R | | | | | | |
| A48V | S103A | V104I | G159D | A230V | Q236H | Q245R | | | | | | | |
| A48V | V68A | S103A | V104I | G159D | Y209W | A232V | Q236H | Q245R | | | | | |
| A48V | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| A48V | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | N261W | | | | |
| G102A | S103A | V104I | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | | | | |
| Q12R | G102A | S103A | V104I | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | G102A | S103A | V104I | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | | | |
| A98L | G102A | S103A | V104I | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | | | |
| G102A | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S103A | V104I | P131V | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | | |
| S103A | V104I | G159D | N184S | A232V | Q236H | Q245R | N248D | N252K | | | | | |
| S103A | V104I | G159D | N184G | A232V | Q236H | Q245R | N248D | N252K | | | | | |
| S103A | V104I | G159D | A232V | Q236H | V244T | Q245R | N248D | N252K | | | | | |

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| S103A | V104I | G159D | A232V | Q236H | V244A | Q245R | N248D | N252K | | | | |
| N62D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | S256R | | |
| Q12R | N62D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| S101G | S103A | V104I | G159D | N185D | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | G159D | Q206E | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | G159D | T213Q | A232V | Q236H | Q245R | N248D | N252K | | | |
| A98L | G102A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | G102A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| A98L | G102A | S103A | V104I | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | | |
| A98L | G102A | S103A | V104I | G159D | S212G | A232V | Q236H | N248D | N252K | | | |
| N62D | S103A | V104I | Q109R | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| N62D | S103A | V104I | G159D | S212G | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| N62D | S101G | S103A | V104I | G159D | S212G | T213R | A232V | Q236H | Q245R | N248D | N252K | |
| S103A | V104I | G159D | A232V | Q245R | N248D | N252K | | | | | | |
| S103A | V104I | G159D | A230V | Q245R | | | | | | | | |
| N62D | S103A | V104I | S130G | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| S101G | S103A | V104I | S130G | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | S128G | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | S128L | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| N62D | S101G | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| N62D | S103A | V104I | S128G | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| N62D | S103A | V104I | S128L | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| S101G | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | T260A | | | |
| S101G | S103A | V104I | P131V | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| A98V | S101G | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| S99G | S101G | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | | | |
| | | | | | | | | | | | | |
| S101G | S103A | V104I | G159D | Y209W | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | G159D | P210I | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | G159D | V205I | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | G159D | A230V | Q236H | Q245R | | | | | | |
| S101G | S103A | V104I | G159D | A194P | A232V | Q236H | Q245R | N248D | N252K | | | |
| N76D | S101G | S103A | V104I | G159D | A194P | A232V | Q236H | Q245R | N248D | N252K | | |
| S101G | S103A | V104I | G159D | A230V | A232V | Q236H | Q245R | N248D | N252K | | | |
| N62D | S103A | V104I | G159D | N185D | Q206E | T213R | A232V | Q236H | Q245R | N248D | N252K | E271Q |

Still yet an even more preferred protease variant useful in the cleaning composition of the present invention include a substitution set selected from the group consisting of the substitution sets in Table I except for the following substitution sets of Table III:

Table III

| | | | | | | | | | | |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 76 | 103 | 104 | 259 | | | | | | | |
| 76 | 86 | 103 | 104 | | | | | | | |
| 76 | 103 | 104 | 130 | | | | | | | |
| 76 | 99 | 103 | 104 | 204 | | | | | | |
| 76 | 103 | 104 | 242 | | | | | | | |
| 76 | 103 | 104 | 104 | 182 | 198 | | | | | |
| 21 | 76 | 103 | 104 | 182 | | | | | | |
| 76 | 103 | 104 | 119 | 137 | | | | | | |
| 76 | 103 | 104 | 173 | 222 | | | | | | |
| 61 | 76 | 103 | 104 | 222 | | | | | | |
| 68 | 76 | 103 | 104 | 116 | 159 | 170 | 185 | 232 | 236 | 245 |

Still yet an even more preferred protease variant useful in the cleaning composition of the present invention include a substitution set selected from the group consisting of the substitution sets in Table IV:

Table IV

| | | | | | | | | | | |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| 76 | 103 | 104 | 222 | 245 | | | | | | |
| 76 | 103 | 104 | 222 | 249 | | | | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 252 | | | |
| 68 | 76 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 260 | |
| 22 | 68 | 76 | 103 | 104 | | | | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | | | | |
| 68 | 103 | 104 | 140 | 159 | 232 | 236 | 245 | 252 | | |
| 43 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 252 | | |
| 43 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | | | |
| 12 | 76 | 103 | 104 | 130 | 222 | 245 | 261 | | | |
| 76 | 103 | 104 | 130 | 222 | 245 | | | | | |

| | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 257 | | | | |
| 68 | 76 | 103 | 104 | 159 | 210 | 232 | 236 | 245 | | | |
| 68 | 103 | 104 | 159 | 224 | 232 | 236 | 245 | 257 | | | |
| 76 | 103 | 104 | 159 | 232 | 236 | 245 | 257 | | | | |
| 68 | 76 | 103 | 104 | 159 | 211 | 232 | 236 | 245 | | | |
| 12 | 68 | 76 | 103 | 104 | 159 | 214 | 232 | 236 | 245 | | |
| 68 | 76 | 103 | 104 | 159 | 215 | 232 | 236 | 245 | | | |
| 12 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | | | |
| 20 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 259 | | |
| 68 | 76 | 87 | 103 | 104 | 159 | 232 | 236 | 245 | 260 | | |
| 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 261 | | | |
| 12 | 48 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | | |
| 76 | 103 | 104 | 159 | 192 | 232 | 236 | 245 | | | | |
| 76 | 103 | 104 | 147 | 159 | 232 | 236 | 245 | 248 | 251 | | |
| 12 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 272 | | |
| 68 | 76 | 103 | 104 | 159 | 183 | 206 | 232 | 236 | 245 | | |
| 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 256 | | | |
| 68 | 76 | 103 | 104 | 159 | 206 | 232 | 236 | 245 | | | |
| 27 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | | | |
| 68 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | |
| 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 68 | 103 | 104 | 159 | 209 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 103 | 104 | 109 | 159 | 232 | 236 | 245 | 248 | 252 | | |
| 20 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 103 | 104 | 159 | 209 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 103 | 104 | 159 | 210 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 103 | 104 | 213 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 215 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 103 | 104 | 159 | 216 | 232 | 236 | 245 | 248 | 252 | | |
| 20 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | |

| | | | | | | | | | | | |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 255 | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 256 | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 260 | | |
| 68 | 103 | 104 | 159 | 228 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 76 | 89 | 103 | 104 | 159 | 210 | 213 | 232 | 236 | 245 | 260 |
| 68 | 103 | 104 | 159 | 218 | 232 | 236 | 245 | 248 | 252 | | |

Still yet an even more preferred protease variant useful in the cleaning composition of the present invention include a substitution set selected from the group consisting of the substitution sets in Table V:

Table V

| | | | | | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| V68A | S103A | V104I | G159D | A228V | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | N218S | A232V | Q236H | Q245R | N248D | N252K | | |
| G20R | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | N76D | E89D | S103A | V104I | G159D | P210L | T213R | A232V | Q236H | Q245R | T260A |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | S256R | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | T260R | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | T255V | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | S256N | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252L | | | |
| V68A | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | A215V | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | A215R | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | S216T | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | S216V | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | T213S | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | P210L | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | S212C | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | | |
| S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| V68A | S103A | V104I | G159D | Y209W | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | Q109R | G159D | A232V | Q236H | Q245R | N248D | N252K | | |
| G20R | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | Y209F | A232V | Q236H | Q245R | N248D | N252K | | |

| | | | | | | | | | | | |
|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|
| Q12R | N76D | S103A | I104T | S130T | M222S | Q245R | N261D | | | | |
| N76D | S103A | I104T | S130T | M222S | Q245R | | | | | | |
| N76D | S103A | V104I | M222S | H249R | | | | | | | |
| N76D | S103A | V104I | M222S | Q245R | | | | | | | |
| N76D | S103A | V104I | G159D | Y192F | A232V | Q236H | Q245R | | | | |
| N76D | S103A | V104I | V147I | G159D | A232V | Q236H | Q245R | N248S | K251R | | |
| Q12R | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | A272S | | |
| V68A | N76D | S103A | V104I | G159D | N183K | Q206L | A232V | Q236H | Q245R | | |
| V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | S256R | | | |
| V68A | N76D | S103A | V104I | G159D | Q206R | A232V | Q236H | Q245R | | | |
| K27R | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | | | |
| Q12R | A48V | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | | |
| V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | N261W | | | |
| V68A | N76D | S103A | V104I | G159D | G211R | A232V | Q236H | Q245R | | | |
| V68A | N76D | S103A | V104I | G159D | G211V | A232V | Q236H | Q245R | | | |
| Q12R | V68A | N76D | S103A | V104I | G159D | Y214L | A232V | Q236H | Q245R | | |
| V68A | N76D | S103A | V104I | G159D | A215R | A232V | Q236H | Q245R | | | |
| Q12R | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | | | |
| G20R | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | S259G | | |
| V68A | N76D | S87R | S103A | V104I | G159D | A232V | Q236H | Q245R | T260V | | |
| N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | | | | |
| V68A | N76D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | T260A | | |
| T22K | V68A | N76D | S103A | V104I | | | | | | | |
| V68A | N76D | S103A | V104I | G159D | P210R | A232V | Q236H | Q245R | | | |
| V68A | S103A | V104I | G159D | S212P | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | T224A | A232V | Q236H | Q245R | L257V | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N252S | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N252K | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | N140D | G159D | A232V | Q236H | Q245R | N252K | | | |
| N43S | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N252K | | | |
| N43K | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | |
| N43D | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N252K | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | | | | |

A highly preferred protease variant useful in the cleaning compositions of the present invention include a substitution set selected from the group consisting of:

12/102/103/104/159/212/232/236/245/248/252; 12/76/103/104/130/170/185/222/243/245;
12/76/103/104/130/222/245/261; 12/76/103/104/130/222/245;
12/76/103/104/222/245;
61/68/103/104/159/232/236/245/248/252; 62/103/104/159/213/232/236/245/248/252;
62/103/104/109/159/213/232/236/245/248/252; 62/103/104/159/232/236/245/248/252;
62/101/103/104/159/212/213/232/236/245/248/252;
62/103/104/130/159/213/232/236/245/248/252; 68/103/104/159/232/236/245/248/252/270;
68/103/104/159/185/232/236/245/248/252; 68/103/104/159/210/232/236/245/248/252;
68/103/104/159/185/210/232/236/245/248/252; 68/103/104/159/213/232/236/245/248/252;
68/103/104/159/230/232/236/245; 68/76/103/104/159/209/232/236/245;
68/103/104/232/236/245/248/257/275; 68/103/104/213/232/236/245/248/252;
68/103/104/159/232/236/245/248/252; 68/103/104/159/209/232/236/245;
68/76/103/104/159/236; 68/76/103/104/159/236/245;
68/76/103/104/159/232/236/245; 68/103/104/159/232/236/245/252;
68/103/104/159/232/236/245; 68/103/104/159/232/236/245/257;
68/76/103/104/159/211/232/236/245; 68/76/103/104/159/215/232/236/245;
68/103/104/159/210/232/236/245; 68/103/104/159/213/232/236/245/260;
68/76/103/104/159/213/232/236/245/260; 68/103/104/159/236;
68/76/103/104/159/210/232/236/245/260; 68/103/104/159/236/245;
68/103/104/159/183/232/236/245/248/252; 68/76/103/104/159/236/245;
68/103/104/232/236/245/257/275; 68/103/104/159/213/232/236/245;
76/103/222/245; 76/103/104/222/245;
76/103/104/159/232/236/245;
76/103/104/159/213/232/236/245/260; 76/103/104/159;
76/103/104/131/159/232/236/245/248/252; 97/103/104/159/232/236/245/248/252;
98/102/103/104/159/212/232/236/245/248/252; 98/103/104/159/232/236/245/248/252;
101/103/104/159/232/236/245/248/252; 102/103/104/159/232/236/245/248/252;
103/104/159/232/236/245; 103/104/159/232/236/245/248/252;
103/104/159/205/209/232/236/245/257; 103/104/159/232/245/248/252;
103/104/159/205/209/210/232/236/245/257; 103/104/159/213/232/236/245/248/252;
103/104/159/217/232/236/245/248/252; 103/104/130/159/232/236/245/248/252;
103/104/159/230/236/245; 103/104/159/236/245;
103/104/159/248/252/270; 103/104/131/159/232/236/245/248/252;
103/104/159/205/209/232/236/245; and 103/104/159/232/236/245/257.

A more highly preferred protease variant useful in the cleaning compositions of the present invention include a substitution set selected from the group consisting of:

12R/76D/103A/104T/130T/222S/245R;
12R/76D/103A/104I/222S/245R;
12R/102A/103A/104I/159D/212G/232V/236H/245R/248D/252K;
12R/76D/103A/104T/130G/222S/245R/261D;
12R/76D/103A/104T/130G/170S/185D/222S/243D/245R;
61E/68A/103A/104I/159D/232V/236H/245R/248D/252K;
62D/103A/104I/109R/159D/213R/232V/236H/245R/248D/252K;
62D/103A/104I/159D/213R/232V/236H/245R/248D/252K;
62D/103A/104I/159D/232V/236H/245R/248D/252K;
62D/103A/104I/130G/159D/213R/232V/236H/245R/248D/252K;
62D/101G/103A/104I/159D/212G/213R/232V/236H/245R/248D/252K;
68A/103A/104I/159D/232V/236H/245R/248D/252K/270A;
68A/76D/103A/104I/159D/213R/232V/236H/245R/260A;
68A/103A/104I/159D/236H;
68A/103A/104I/159D/236H/245R;
68A/76D/103A/104I/159D/210I/232V/236H/245R/260A;
68A/103A/104I/159D/183D/232V/236H/245R/248D/252K;
68A/103A/104I/159D/209W/232V/236H/245R;
68A/76D/103A/104I/159D/211R/232V/236H/245R;
68A/76D/103A/104I/159D/215R/232V/236H/245R;
68A/103A/104I/159D/213R/232V/236H/245R/260A;
68A/76D/103A/104I/159D/236H;
68A/76D/103A/104I/159D/236H/245R;
68A/76D/103A/104I/159D/232V/236H/245R;
68A/103A/104I/159D/232V/236H/245R/252K;
68A/103A/104I/159D/232V/236H/245R;
68A/103A/104I/159D/232V/236H/245R/257V;
68A/103A/104I/159D/185D/232V/236H/245R/248D/252K;
68A/103A/104I/159D/210L/232V/236H/245R/248D/252K;
68A/103A/104I/159D/185D/210L/232V/236H/245R/248D/252K;
68A/103A/104I/159D/213E/232V/236H/245R/248D/252K;
68A/103A/104I/159D/230V/232V/236H/245R;

68A/76D/103A/104I/159D/209W/232V/236H/245R;
68A/103A/104I/232V/236H/245R/248D/257V/275H;
68A/103A/104I/232V/236H/245R/257V/275H;
68A/103A/104I/213E/232V/236H/245R/248D/252K;
68A/103A/104I/159D/232V/236H/245R/248D/252K;
68A/103A/104I/159D/210I/232V/236H/245R;
68A/103A/104I/159D/210L/232V/236H/245R;
68A/103A/104I/159D/213G/232V/236H/245R;
76D/103A/222S/245R;
76D/103A/104I/222S/245R;
76D/103A/104I/159D/232V/236H/245R;
76D/103A/104I/159D;
76D/103A/104I/131V/159D/232V/236H/245R/248D/252K;
76D/103A/104I/159D/213R/232V/236H/245R/260A;
97E/103A/104I/159D/232V/236H/245R/248D/252K;
98L/103A/104I/159D/232V/236H/245R/248D/252K;
98L/102A/103A/104I/159D/212G/232V/236H/245R/248D/252K;
101G/103A/104I/159D/232V/236H/245R/248D/252K;
102A/103A/104I/159D/232V/236H/245R/248D/252K;
103A/104I/159D/232V/236H/245R/248D/252K;
103A/104I/159D/213R/232V/236H/245R/248D/252K;
103A/104I/130G/159D/232V/236H/245R/248D/252K;
103A/104I/159D/230V/236H/245R;
103A/104I/159D/217E/232V/236H/245R/248D/252K;
103A/104I/159D/236H/245R;
103A/104I/159D/248D/252K/270V;
103A/104I/159D/232V/236H/245R;
103A/104I/159D/205I/209W/232V/236H/245R;
103A/104I/159D/232V/236H/245R/257V;
103A/104I/159D/205I/209W/232V/236H/245R/257V;
103A/104I/131V/159D/232V/236H/245R/248D/252K;
103A/104I/159D/205I/209W/210I/232V/236H/245R/257V; and
103A/104I/159D/232V/245R/248D/252K.

An even more highly preferred protease variant useful in the cleaning compositions of the present invention include a substitution set selected from the group consisting of:

12/76/103/104/130/222/245/261;
62/103/104/159/232/236/245/248/252;
62/103/104/159/213/232/236/245/248/252;
62/101/103/104/159/212/213/232/236/245/248/252;
68/103/104/159/232/236/245;
68/103/104/159/230/232/236/245;
68/103/104/159/209/232/236/245;
68/103/104/159/232/236/245/257;
68/76/103/104/159/213/232/236/245/260;
68/103/104/159/213/232/236/245/248/252;
68/103/104/159/183/232/236/245/248/252;
68/103/104/159/185/232/236/245/248/252;
68/103/104/159/185/210/232/236/245/248/252;
68/103/104/159/210/232/236/245/248/252;
68/103/104/159/213/232/236/245;
98/103/104/159/232/236/245/248/252;
98/102/103/104/159/212/232/236/245/248/252;
101/103/104/159/232/236/245/248/252;
102/103/104/159/232/236/245/248/252;
103/104/159/230/236/245;
103/104/159/232/236/245/248/252;
103/104/159/217/232/236/245/248/252;
103/104/130/159/232/236/245/248/252;
103/104/131/159/232/236/245/248/252;
103/104/159/213/232/236/245/248/252; and
103/104/159/232/236/245.

The most highly preferred protease variant useful in the cleaning compositions of the present invention include a substitution set selected from the group consisting of:

12R/76D/103A/104T/130T/222S/245R/261D;
62D/103A/104I/159D/232V/236H/245R/248D/252K;
62D/103A/104I/159D/213R/232V/236H/245R/248D/252K;
68A/103A/104I/159D/209W/232V/236H/245R;
68A/76D/103A/104I/159D/213R/232V/236H/245R/260A;
68A/103A/104I/159D/213E/232V/236H/245R/248D/252K;
68A/103A/104I/159D/183D/232V/236H/245R/248D/252K;

68A/103A/104I/159D/232V/236H/245R;
 68A/103A/104I/159D/230V/232V/236H/245R;
 68A/103A/104I/159D/232V/236H/245R/257V;
 68A/103A/104I/159D/213G/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/185D/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/185D/210L/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/210L/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/213G/232V/236H/245R;
 98L/103A/104I/159D/232V/236H/245R/248D/252K;
 98L/102A/103A/104I/159D/212G/232V/236H/245R/248D/252K;
 101G/103A/104I/159D/232V/236H/245R/248D/252K;
 102A/103A/104I/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/230V/236H/245R;
 103A/104I/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/217E/232V/236H/245R/248D/252K;
 103A/104I/130G/159D/232V/236H/245R/248D/252K;
 103A/104I/131V/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/213R/232V/236H/245R/248D/252K; and
 103A/104I/159D/232V/236H/245R.

In another preferred embodiment, the protease variants which are the protease enzymes useful in the cleaning compositions of the present invention comprise protease variants including a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 62, 212, 230, 232, 252 and 257 of *Bacillus amyloliquefaciens* subtilisin.

While any combination of the above listed amino acid substitutions may be employed, the preferred protease variant enzymes useful for the present invention comprise the substitution, deletion or insertion of amino acid residues in the following combinations:

- (1) a protease variant including substitutions of the amino acid residues at position 62 and at one or more of the following positions 103, 104, 109, 159, 213, 232, 236, 245, 248 and 252;
- (2) a protease variant including substitutions of the amino acid residues at position 212 and at one or more of the following positions 12, 98, 102, 103, 104, 159, 232, 236, 245, 248 and 252;
- (3) a protease variant including substitutions of the amino acid residues at position 230 and at one or more of the following positions 68, 103, 104, 159, 232, 236 and 245;

(4) a protease variant including substitutions of the amino acid residues at position 232 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;

(5) a protease variant including substitutions of the amino acid residues at position 232 and at one or more of the following positions 103, 104, 236 and 245;

(6) a protease variant including substitutions of the amino acid residues at position 232 and 103 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;

(7) a protease variant including substitutions of the amino acid residues at position 232 and 104 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;

(8) a protease variant including substitutions of the amino acid residues at position 232 and 236 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;

(9) a protease variant including substitutions of the amino acid residues at position 232 and 245 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;

(10) a protease variant including substitutions of the amino acid residues at position 232, 103, 104, 236 and 245 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;

(11) a protease variant including substitutions of the amino acid residues at position 252 and at one or more of the following positions 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;

(12) a protease variant including substitutions of the amino acid residues at position 252 and at one or more of the following positions 103, 104, 236 and 245;

(13) a protease variant including substitutions of the amino acid residues at positions 252 and 103 and at one or more of the following positions 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;

(14) a protease variant including substitutions of the amino acid residues at positions 252 and 104 and at one or more of the following positions 12, 61, 62, 68, 97, 98,

101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;

(15) a protease variant including substitutions of the amino acid residues at positions 252 and 236 and at one or more of the following positions 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;

(16) a protease variant including substitutions of the amino acid residues at positions 252 and 245 and at one or more of the following positions 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;

(17) a protease variant including substitutions of the amino acid residues at positions 252, 103, 104, 236 and 245 and at one or more of the following positions 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270; and

(18) a protease variant including substitutions of the amino acid residues at position 257 and at one or more of the following positions 68, 103, 104, 205, 209, 210, 232, 236, 245 and 275.

A more preferred protease variant useful in the cleaning compositions of the present invention include a substitution set (one substitution set per row in the following Table VI) selected from the group consisting of:

Table VI

| | | | | | | | | | | | | |
|----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|--|--|
| 76 | 103 | 104 | 212 | 271 | | | | | | | | |
| 76 | 103 | 104 | 252 | 261 | | | | | | | | |
| 76 | 103 | 104 | 212 | 258 | | | | | | | | |
| 4 | 76 | 103 | 104 | 159 | 217 | 252 | | | | | | |
| 12 | 62 | 76 | 103 | 104 | 159 | | | | | | | |
| 76 | 103 | 104 | 212 | 268 | 271 | | | | | | | |
| 76 | 87 | 103 | 104 | 212 | 271 | | | | | | | |
| 76 | 103 | 104 | 212 | 245 | 271 | | | | | | | |
| 76 | 103 | 104 | 134 | 141 | 212 | 271 | | | | | | |
| 76 | 103 | 104 | 212 | 236 | 243 | 271 | | | | | | |
| 20 | 62 | 76 | 103 | 104 | | | | | | | | |
| 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | | | | | |
| 76 | 103 | 104 | 232 | 245 | | | | | | | | |
| 24 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | | | | |

| | | | | | | | | | | | | |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|--|
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 252 | | | | | |
| 68 | 76 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 260 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | | | | | | |
| 68 | 103 | 104 | 140 | 159 | 232 | 236 | 245 | 252 | | | | |
| 43 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 252 | | | | |
| 43 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | | | | | |
| 43 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 252 | | | | |
| 68 | 87 | 103 | 104 | 159 | 232 | 236 | 245 | 252 | 275 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 257 | | | | | |
| 68 | 103 | 104 | 116 | 159 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | | | | | |
| 10 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 203 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 237 | 245 | | | | | |
| 68 | 76 | 79 | 103 | 104 | 159 | 232 | 236 | 245 | | | | |
| 68 | 103 | 104 | 159 | 183 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 174 | 206 | 232 | 236 | 245 | | | | |
| 68 | 103 | 104 | 159 | 188 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 230 | 232 | 236 | 245 | | | | | |
| 68 | 98 | 103 | 104 | 159 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 215 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | | | | | |
| 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | | | | | |
| 68 | 76 | 103 | 104 | 159 | 210 | 232 | 236 | 245 | | | | |
| 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 257 | | | | |
| 76 | 103 | 104 | 232 | 236 | 245 | 257 | | | | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 257 | 275 | | | | |
| 76 | 103 | 104 | 257 | 275 | | | | | | | | |
| 68 | 103 | 104 | 159 | 224 | 232 | 236 | 245 | 257 | | | | |
| 76 | 103 | 104 | 159 | 232 | 236 | 245 | 257 | | | | | |
| 68 | 76 | 103 | 104 | 159 | 209 | 232 | 236 | 245 | | | | |
| 68 | 76 | 103 | 104 | 159 | 211 | 232 | 236 | 245 | | | | |
| 12 | 68 | 76 | 103 | 104 | 159 | 214 | 232 | 236 | 245 | | | |
| 68 | 76 | 103 | 104 | 159 | 215 | 232 | 236 | 245 | | | | |
| 12 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | | | | |

| | | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|
| 20 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 259 | | | |
| 68 | 87 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 260 | | | |
| 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 261 | | | | |
| 76 | 103 | 104 | 232 | 236 | 242 | 245 | | | | | | |
| 68 | 76 | 103 | 104 | 159 | 210 | 232 | 236 | 245 | | | | |
| 12 | 48 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | | | |
| 76 | 103 | 104 | 232 | 236 | 245 | | | | | | | |
| 76 | 103 | 104 | 159 | 192 | 232 | 236 | 245 | | | | | |
| 76 | 103 | 104 | 147 | 159 | 232 | 236 | 245 | 248 | 251 | | | |
| 12 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 272 | | | |
| 68 | 76 | 103 | 104 | 159 | 183 | 206 | 232 | 236 | 245 | | | |
| 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 256 | | | | |
| 68 | 76 | 103 | 104 | 159 | 206 | 232 | 236 | 245 | | | | |
| 27 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | | | | |
| 68 | 76 | 103 | 104 | 116 | 159 | 170 | 185 | 232 | 236 | 245 | | |
| 61 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 43 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 99 | 159 | 184 | 232 | 236 | 245 | 248 | 252 | | |
| 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | | |
| 68 | 103 | 104 | 159 | 209 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 109 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 20 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 209 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 261 | | | |
| 68 | 103 | 104 | 159 | 185 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 210 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 185 | 210 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 213 | 232 | 236 | 245 | 248 | 252 | | | | |
| 68 | 103 | 104 | 159 | 215 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 216 | 232 | 236 | 245 | 248 | 252 | | | |
| 20 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 173 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 251 | 252 | | | |

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|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| 68 | 103 | 104 | 159 | 206 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 55 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 255 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 256 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 260 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 257 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 258 | | | |
| 8 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 269 | | |
| 68 | 103 | 104 | 116 | 159 | 232 | 236 | 245 | 248 | 252 | 260 | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 261 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 261 | | | |
| 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 232 | 236 | 245 | 248 | 252 | | | | | |
| 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 18 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 68 | 76 | 101 | 103 | 104 | 159 | 213 | 218 | 232 | 236 | 245 | 260 | |
| 68 | 103 | 104 | 159 | 228 | 232 | 236 | 245 | 248 | 252 | | | |
| 33 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 76 | 89 | 103 | 104 | 159 | 210 | 213 | 232 | 236 | 245 | 260 | |
| 61 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | |
| 103 | 104 | 159 | 205 | 210 | 232 | 236 | 245 | | | | | |
| 61 | 68 | 103 | 104 | 130 | 159 | 232 | 236 | 245 | 248 | 252 | | |
| 61 | 68 | 103 | 104 | 133 | 137 | 159 | 232 | 236 | 245 | 248 | 252 | |
| 61 | 103 | 104 | 133 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 68 | 103 | 104 | 159 | 218 | 232 | 236 | 245 | 248 | 252 | | | |
| 61 | 68 | 103 | 104 | 159 | 160 | 232 | 236 | 245 | 248 | 252 | | |
| 3 | 61 | 68 | 76 | 103 | 104 | 232 | 236 | 245 | 248 | 252 | | |
| 61 | 68 | 103 | 104 | 159 | 167 | 232 | 236 | 245 | 248 | 252 | | |
| 97 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 98 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 99 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 101 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |

| | | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|
| 102 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 103 | 104 | 106 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 103 | 104 | 109 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 261 | | | | |
| 62 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 103 | 104 | 159 | 184 | 232 | 236 | 245 | 248 | 252 | | | | |
| 103 | 104 | 159 | 166 | 232 | 236 | 245 | 248 | 252 | | | | |
| 103 | 104 | 159 | 217 | 232 | 236 | 245 | 248 | 252 | | | | |
| 20 | 62 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | |
| 62 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | | |
| 103 | 104 | 159 | 206 | 217 | 232 | 236 | 245 | 248 | 252 | | | |
| 62 | 103 | 104 | 159 | 206 | 232 | 236 | 245 | 248 | 252 | | | |
| 103 | 104 | 130 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 103 | 104 | 131 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 27 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 38 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 38 | 76 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 260 | | | |
| 68 | 76 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 260 | 271 | | |
| 68 | 76 | 103 | 104 | 159 | 209 | 213 | 232 | 236 | 245 | 260 | | |
| 68 | 76 | 103 | 104 | 159 | 210 | 213 | 232 | 236 | 245 | 260 | | |
| 68 | 76 | 103 | 104 | 159 | 205 | 213 | 232 | 236 | 245 | 260 | | |
| 68 | 76 | 103 | 104 | 159 | 210 | 232 | 236 | 245 | 260 | | | |
| 68 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 260 | | | | |
| 76 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 260 | | | | |
| 68 | 103 | 104 | 159 | 209 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 210 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 230 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 126 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 205 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 159 | 210 | 232 | 236 | 245 | | | | | |
| 103 | 104 | 159 | 230 | 236 | 245 | | | | | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 260 | | | | | |
| 103 | 104 | 159 | 232 | 236 | 245 | | | | | | | |
| 68 | 103 | 104 | 159 | 174 | 232 | 236 | 245 | 257 | | | | |
| 68 | 103 | 104 | 159 | 194 | 232 | 236 | 245 | 257 | | | | |
| 68 | 103 | 104 | 159 | 209 | 232 | 236 | 245 | 257 | | | | |

| | | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|
| 103 | 104 | 159 | 232 | 236 | 245 | 257 | | | | | | |
| 68 | 76 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 260 | 261 | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 257 | 261 | | | | |
| 103 | 104 | 159 | 213 | 232 | 236 | 245 | 260 | | | | | |
| 103 | 104 | 159 | 210 | 232 | 236 | 245 | 248 | 252 | | | | |
| 103 | 104 | 159 | 209 | 232 | 236 | 245 | 257 | | | | | |
| 68 | 76 | 103 | 104 | 159 | 210 | 213 | 232 | 236 | 245 | 260 | | |
| 12 | 103 | 104 | 159 | 209 | 213 | 232 | 236 | 245 | 260 | | | |
| 103 | 104 | 209 | 232 | 236 | 245 | 257 | | | | | | |
| 103 | 104 | 159 | 205 | 210 | 213 | 232 | 236 | 245 | 260 | | | |
| 103 | 104 | 159 | 205 | 209 | 232 | 236 | 245 | 260 | | | | |
| 68 | 103 | 104 | 159 | 205 | 209 | 210 | 232 | 236 | 245 | | | |
| 103 | 104 | 159 | 205 | 209 | 210 | 232 | 236 | 245 | 257 | | | |
| 103 | 104 | 159 | 205 | 209 | 232 | 236 | 245 | 257 | | | | |
| 68 | 103 | 104 | 159 | 205 | 209 | 210 | 232 | 236 | 245 | 260 | | |
| 103 | 104 | 159 | 205 | 209 | 210 | 232 | 236 | 245 | | | | |
| 103 | 104 | 159 | 209 | 210 | 232 | 236 | 245 | | | | | |
| 103 | 104 | 159 | 205 | 210 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 128 | 159 | 232 | 236 | 245 | | | | | |
| 48 | 103 | 104 | 159 | 230 | 236 | 245 | | | | | | |
| 48 | 68 | 103 | 104 | 159 | 209 | 232 | 236 | 245 | | | | |
| 48 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 48 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 257 | 261 | | | |
| 102 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | | |
| 12 | 102 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | |
| 101 | 102 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | |
| 98 | 102 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | |
| 102 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | | |
| 103 | 104 | 131 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 103 | 104 | 159 | 184 | 232 | 236 | 245 | 248 | 252 | | | | |
| 103 | 104 | 159 | 232 | 236 | 244 | 245 | 248 | 252 | | | | |
| 62 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | 256 | | |
| 12 | 62 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | |
| 101 | 103 | 104 | 159 | 185 | 232 | 236 | 245 | 248 | 252 | | | |
| 101 | 103 | 104 | 159 | 206 | 232 | 236 | 245 | 248 | 252 | | | |
| 101 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | | |

| | | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 98 | 102 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 101 | 102 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 98 | 102 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | |
| 98 | 102 | 103 | 104 | 159 | 212 | 232 | 236 | 248 | 252 | | | |
| 62 | 103 | 104 | 109 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | |
| 62 | 103 | 104 | 159 | 212 | 213 | 232 | 236 | 245 | 248 | 252 | | |
| 62 | 101 | 103 | 104 | 159 | 212 | 213 | 232 | 236 | 245 | 248 | 252 | |
| 103 | 104 | 159 | 232 | 245 | 248 | 252 | | | | | | |
| 103 | 104 | 159 | 230 | 245 | | | | | | | | |
| 62 | 103 | 104 | 130 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | |
| 101 | 103 | 104 | 130 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 101 | 103 | 104 | 128 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 62 | 101 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | |
| 62 | 103 | 104 | 128 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | |
| 62 | 103 | 104 | 128 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | |
| 101 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 260 | | | |
| 101 | 103 | 104 | 131 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 98 | 101 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 99 | 101 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 101 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | | |
| 101 | 103 | 104 | 159 | 209 | 232 | 236 | 245 | 248 | 252 | | | |
| 101 | 103 | 104 | 159 | 210 | 232 | 236 | 245 | 248 | 252 | | | |
| 101 | 103 | 104 | 159 | 205 | 232 | 236 | 245 | 248 | 252 | | | |
| 101 | 103 | 104 | 159 | 230 | 236 | 245 | | | | | | |
| 101 | 103 | 104 | 159 | 194 | 232 | 236 | 245 | 248 | 252 | | | |
| 76 | 101 | 103 | 104 | 159 | 194 | 232 | 236 | 245 | 248 | 252 | | |
| 101 | 103 | 104 | 159 | 230 | 232 | 236 | 245 | 248 | 252 | | | |
| 62 | 103 | 104 | 159 | 185 | 206 | 213 | 232 | 236 | 245 | 248 | 252 | 271 |

An even more preferred protease variant useful in the cleaning compositions of the present invention include a substitution set (one substitution set per row in the following Table VII) selected from the group consisting of:

Table VII

| | | | | | | | | | | | | |
|------|-------|-------|-------|-------|--|--|--|--|--|--|--|--|
| N76D | S103A | V104I | S212P | E271V | | | | | | | | |
| N76D | S103A | V104I | N252K | N261Y | | | | | | | | |

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|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|--|
| N76D | S103A | V104I | S212P | G258R | | | | | | | | |
| V4E | N76D | S103A | V104I | G159D | L217E | N252D | | | | | | |
| Q12H | N62H | N76D | S103A | V104I | G159D | | | | | | | |
| N76D | S103A | V104I | S212P | V268F | E271V | | | | | | | |
| N76D | S87R | S103A | V104I | S212P | E271V | | | | | | | |
| N76D | S103A | V104I | S212P | Q245L | E271V | | | | | | | |
| N76D | S103A | V104I | T134S | S141N | S212P | E271V | | | | | | |
| N76D | S103A | V104I | S212P | Q236L | N243S | E271V | | | | | | |
| G20V | N62S | N76D | S103A | V104I | | | | | | | | |
| V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | | |
| N76D | S103A | V104I | A232V | Q245R | | | | | | | | |
| S24T | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N252K | | | | | |
| V68A | N76D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | T260A | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | | | |
| V68A | S103A | V104I | N140D | G159D | A232V | Q236H | Q245R | N252K | | | | |
| N43S | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N252K | | | | |
| N43K | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | | |
| N43D | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N252K | | | | |
| V68A | S87G | S103A | V104I | G159D | A232V | Q236H | Q245R | N252K | R275S | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | | | | | |
| V68A | S103A | V104I | N116D | G159D | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | | | | | |
| R10C | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | V203E | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | K237E | Q245R | | | | | |
| V68A | N76D | I79N | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | |
| V68A | S103A | V104I | G159D | N183D | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | A174V | Q206L | A232V | Q236H | Q245R | | | | |
| V68A | S103A | V104I | G159D | S188C | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | A230T | A232V | Q236H | Q245R | | | | | |
| V68A | A98T | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | A215T | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248S | | | | | |
| V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | | |

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|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|
| V68A | N76D | S103A | V104I | G159D | P210R | A232V | Q236H | Q245R | | | | |
| V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | | | | |
| N76D | S103A | V104I | A232V | Q236H | Q245R | L257V | | | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | R275H | | | | |
| N76D | S103A | V104I | L257V | R275H | | | | | | | | |
| V68A | S103A | V104I | G159D | T224A | A232V | Q236H | Q245R | L257V | | | | |
| N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | | | | | |
| V68A | N76D | S103A | V104I | G159D | Y209W | A232V | Q236H | Q245R | | | | |
| V68A | N76D | S103A | V104I | G159D | G211R | A232V | Q236H | Q245R | | | | |
| V68A | N76D | S103A | V104I | G159D | G211V | A232V | Q236H | Q245R | | | | |
| Q12R | V68A | N76D | S103A | V104I | G159D | Y214L | A232V | Q236H | Q245R | | | |
| V68A | N76D | S103A | V104I | G159D | A215R | A232V | Q236H | Q245R | | | | |
| Q12R | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | |
| G20R | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | S259G | | | |
| V68A | S87R | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | T260V | | | |
| V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | N261G | | | | |
| V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | N261W | | | | |
| N76D | S103A | V104I | A232V | Q236H | S242P | Q245R | | | | | | |
| V68A | N76D | S103A | V104I | G159D | P210L | A232V | Q236H | Q245R | | | | |
| Q12R | A48V | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | | | |
| N76D | S103A | V104I | A232V | Q236H | Q245R | | | | | | | |
| N76D | S103A | V104I | G159D | Y192F | A232V | Q236H | Q245R | | | | | |
| N76D | S103A | V104I | V147I | G159D | A232V | Q236H | Q245R | N248S | K251R | | | |
| Q12R | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | A272S | | | |
| V68A | N76D | S103A | V104I | G159D | N183K | Q206L | A232V | Q236H | Q245R | | | |
| V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | S256R | | | | |
| V68A | N76D | S103A | V104I | G159D | Q206R | A232V | Q236H | Q245R | | | | |
| K27R | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | |
| V68A | N76D | S103A | V104I | N116T | G159D | R170S | N185S | A232V | Q236H | Q245R | | |
| G61E | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| N43D | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | S212P | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | S99N | G159D | N184D | A232V | Q236H | Q245R | N248D | N252K | | |
| S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | | |
| V68A | S103A | V104I | G159D | Y209W | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | Q109R | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |

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|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|
| G20R | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | Y209F | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | N261D | | | |
| V68A | S103A | V104I | G159D | N185D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | P210R | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | P210T | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | P210S | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | N185D | P210L | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | P210L | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | S212A | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | S212E | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | T213E | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | T213S | A232V | Q236H | Q245R | N248D | N252K | | | | |
| V68A | A103V | V104I | G159D | T213E | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | T213G | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | A215V | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | A215R | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | S216T | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | S216V | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | S216C | A232V | Q236H | Q245R | N248D | N252K | | | |
| G20A | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | N173D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | K251V | N252K | | | |
| V68A | S103A | V104I | G159D | Q206R | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252F | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252L | | | | |
| P55S | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252F | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | T255V | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | S256N | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | S256E | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | S256R | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | T260R | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | L257R | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | G258D | | | |

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|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|
| I8V | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | N269D | | |
| V68A | S103A | V104I | N116S | G159D | A232V | Q236H | Q245R | N248D | N252K | T260E | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | N261R | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | N261D | | | |
| V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | A232V | Q236H | Q245R | N248D | N252K | | | | | |
| S103A | V104I | G159D | A232S | Q236H | Q245R | N248D | N252K | | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236R | Q245R | N248D | N252K | | | | |
| N18S | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245V | N248D | N252K | | | | |
| V68A | N76D | S101T | S103A | V104I | G159D | T213R | N218S | A232V | Q236H | Q245R | T260A | |
| V68A | S103A | V104I | G159D | A228V | A232V | Q236H | Q245R | N248D | N252K | | | |
| T33S | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | N76D | E89D | S103A | V104I | G159D | P210L | T213R | A232V | Q236H | Q245R | T260A | |
| G61E | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | |
| S103A | V104I | G159D | V205I | P210I | A232V | Q236H | Q245R | | | | | |
| G61E | V68A | S103A | V104I | S130A | G159D | A232V | Q236H | Q245R | N248D | N252K | | |
| G61E | V68A | S103A | V104I | A133S | Q137R | G159D | A232V | Q236H | Q245R | N248D | N252K | |
| G61E | S103A | V104I | A133V | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248G | N252K | | | | |
| V68A | S103A | V104I | G159D | N218S | A232V | Q236H | Q245R | N248D | N252K | | | |
| G61E | V68A | S103A | V104I | G159D | S160V | A232V | Q236H | Q245R | N248D | N252K | | |
| S3L | G61E | V68A | N76D | S103A | V104I | A232V | Q236H | Q245R | N248D | N252K | | |
| G61E | V68A | S103A | V104I | G159D | S167F | A232V | Q236H | Q245R | N248D | N252K | | |
| G97E | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| A98D | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S99E | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S101E | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S101G | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| G102A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S103A | V104I | S106E | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S103A | V104I | Q109E | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | N261R | | | | |
| S103A | V104I | Q109R | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| N62D | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S103A | V104I | G159D | N184D | A232V | Q236H | Q245R | N248D | N252K | | | | |

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|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|
| S103A | V104I | G159D | S166D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S103A | V104I | G159D | L217E | A232V | Q236H | Q245R | N248D | N252K | | | | |
| G20R | N62D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| N62D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | | |
| S103A | V104I | G159D | Q206R | L217E | A232V | Q236H | Q245R | N248D | N252K | | | |
| N62D | S103A | V104I | G159D | Q206R | A232V | Q236H | Q245R | N248D | N252K | | | |
| S103A | V104I | S130G | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S103A | V104I | P131V | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| K27N | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| T38G | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| T38A | N76D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | T260A | | | |
| V68A | N76D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | T260A | E271G | | |
| V68A | N76D | S103A | V104I | G159D | Y209W | T213R | A232V | Q236H | Q245R | T260A | | |
| V68A | N76D | S103A | V104I | G159D | P210I | T213R | A232V | Q236H | Q245R | T260A | | |
| V68A | N76D | S103A | V104I | G159D | V205I | T213R | A232V | Q236H | Q245R | T260A | | |
| V68A | N76D | S103A | V104I | G159D | P210I | A232V | Q236H | Q245R | T260A | | | |
| V68A | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | T260A | | | | |
| N76D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | T260A | | | | |
| V68A | S103A | V104I | G159D | Y209W | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | P210I | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | A230V | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | L126F | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | V205I | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | G159D | P210L | A232V | Q236H | Q245R | | | | | |
| S103A | V104I | G159D | A230V | Q236H | Q245R | | | | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | T260A | | | | | |
| S103A | V104I | G159D | A232V | Q236H | Q245R | | | | | | | |
| V68A | S103A | V104I | G159D | A174V | A232V | Q236H | Q245R | L257V | | | | |
| V68A | S103A | V104I | G159D | A194S | A232V | Q236H | Q245R | L257V | | | | |
| V68A | S103A | V104I | G159D | Y209W | A232V | Q236H | Q245R | L257V | | | | |
| S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | | | | | | |
| V68A | N76D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | T260A | N261W | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | N261W | | | | |
| S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | T260A | | | | | |
| S103A | V104I | G159D | P210I | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S103A | V104I | G159D | Y209W | A232V | Q236H | Q245R | L257V | | | | | |

| | | | | | | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|
| V68A | N76D | S103A | V104I | G159D | P210L | T213R | A232V | Q236H | Q245R | T260A | | |
| Q12R | S103A | V104I | G159D | Y209W | T213R | A232V | Q236H | Q245R | T260A | | | |
| S103A | V104I | Y209W | A232V | Q236H | Q245R | L257V | | | | | | |
| S103A | V104I | G159D | V205I | P210I | T213R | A232V | Q236H | Q245R | T260A | | | |
| S103A | V104I | G159D | V205I | Y209W | A232V | Q236H | Q245R | T260A | | | | |
| V68A | S103A | V104I | G159D | V205I | Y209W | P210I | A232V | Q236H | Q245R | | | |
| S103A | V104I | G159D | V205I | Y209W | P210I | A232V | Q236H | Q245R | L257V | | | |
| S103A | V104I | G159D | V205I | Y209W | A232V | Q236H | Q245R | L257V | | | | |
| V68A | S103A | V104I | G159D | V205I | Y209W | P210I | A232V | Q236H | Q245R | T260A | | |
| S103A | V104I | G159D | V205I | Y209W | P210I | A232V | Q236H | Q245R | | | | |
| S103A | V104I | G159D | Y209W | P210I | A232V | Q236H | Q245R | | | | | |
| S103A | V104I | G159D | V205I | P210I | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | S128L | G159D | A232V | Q236H | Q245R | | | | | |
| A48V | S103A | V104I | G159D | A230V | Q236H | Q245R | | | | | | |
| A48V | V68A | S103A | V104I | G159D | Y209W | A232V | Q236H | Q245R | | | | |
| A48V | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| A48V | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | N261W | | | |
| G102A | S103A | V104I | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | | | |
| Q12R | G102A | S103A | V104I | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | | |
| S101G | G102A | S103A | V104I | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | | |
| A98L | G102A | S103A | V104I | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | | |
| G102A | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | | |
| S103A | V104I | P131V | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S103A | V104I | G159D | N184S | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S103A | V104I | G159D | N184G | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S103A | V104I | G159D | A232V | Q236H | V244T | Q245R | N248D | N252K | | | | |
| S103A | V104I | G159D | A232V | Q236H | V244A | Q245R | N248D | N252K | | | | |
| N62D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | S256R | | |
| Q12R | N62D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| S101G | S103A | V104I | G159D | N185D | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | G159D | Q206E | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | G159D | T213Q | A232V | Q236H | Q245R | N248D | N252K | | | |
| A98L | G102A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | G102A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| A98L | G102A | S103A | V104I | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | | |
| A98L | G102A | S103A | V104I | G159D | S212G | A232V | Q236H | N248D | N252K | | | |

| | | | | | | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| N62D | S103A | V104I | Q109R | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| N62D | S103A | V104I | G159D | S212G | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| N62D | S101G | S103A | V104I | G159D | S212G | T213R | A232V | Q236H | Q245R | N248D | N252K | |
| S103A | V104I | G159D | A232V | Q245R | N248D | N252K | | | | | | |
| S103A | V104I | G159D | A230V | Q245R | | | | | | | | |
| N62D | S103A | V104I | S130G | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| S101G | S103A | V104I | S130G | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | S128G | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | S128L | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| N62D | S101G | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| N62D | S103A | V104I | S128G | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| N62D | S103A | V104I | S128L | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| S101G | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | T260A | | | |
| S101G | S103A | V104I | P131V | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| A98V | S101G | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| S99G | S101G | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | G159D | Y209W | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | G159D | P210I | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | G159D | V205I | A232V | Q236H | Q245R | N248D | N252K | | | |
| S101G | S103A | V104I | G159D | A230V | Q236H | Q245R | | | | | | |
| S101G | S103A | V104I | G159D | A194P | A232V | Q236H | Q245R | N248D | N252K | | | |
| N76D | S101G | S103A | V104I | G159D | A194P | A232V | Q236H | Q245R | N248D | N252K | | |
| S101G | S103A | V104I | G159D | A230V | A232V | Q236H | Q245R | N248D | N252K | | | |
| N62D | S103A | V104I | G159D | N185D | Q206E | T213R | A232V | Q236H | Q245R | N248D | N252K | E271Q |

Still yet an even more preferred protease variant useful in the cleaning composition of the present invention include a substitution set selected from the group consisting of the substitution sets in Table VI except for the following substitution set of Table VIII:

Table VIII

| | | | | | | | | | | |
|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 68 | 76 | 103 | 104 | 116 | 159 | 170 | 185 | 232 | 236 | 245 |
|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|

Still yet an even more preferred protease variant useful in the cleaning composition of the present invention include a substitution set selected from the group consisting of the substitution sets in Table IX:

Table IX

| | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 252 | | | | |
| 68 | 76 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 260 | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | | | | | |
| 68 | 103 | 104 | 140 | 159 | 232 | 236 | 245 | 252 | | | |
| 43 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 252 | | | |
| 43 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | | | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 257 | | | | |
| 68 | 76 | 103 | 104 | 159 | 210 | 232 | 236 | 245 | | | |
| 68 | 103 | 104 | 159 | 224 | 232 | 236 | 245 | 257 | | | |
| 76 | 103 | 104 | 159 | 232 | 236 | 245 | 257 | | | | |
| 68 | 76 | 103 | 104 | 159 | 211 | 232 | 236 | 245 | | | |
| 12 | 68 | 76 | 103 | 104 | 159 | 214 | 232 | 236 | 245 | | |
| 68 | 76 | 103 | 104 | 159 | 215 | 232 | 236 | 245 | | | |
| 12 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | | | |
| 20 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 259 | | |
| 68 | 76 | 87 | 103 | 104 | 159 | 232 | 236 | 245 | 260 | | |
| 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 261 | | | |
| 12 | 48 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | | |
| 76 | 103 | 104 | 159 | 192 | 232 | 236 | 245 | | | | |
| 76 | 103 | 104 | 147 | 159 | 232 | 236 | 245 | 248 | 251 | | |
| 12 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 272 | | |
| 68 | 76 | 103 | 104 | 159 | 183 | 206 | 232 | 236 | 245 | | |
| 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | 256 | | | |
| 68 | 76 | 103 | 104 | 159 | 206 | 232 | 236 | 245 | | | |
| 27 | 68 | 76 | 103 | 104 | 159 | 232 | 236 | 245 | | | |
| 68 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | |
| 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | | | |
| 68 | 103 | 104 | 159 | 209 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 103 | 104 | 109 | 159 | 232 | 236 | 245 | 248 | 252 | | |
| 20 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | |

| | | | | | | | | | | | |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 68 | 103 | 104 | 159 | 209 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 103 | 104 | 159 | 210 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 103 | 104 | 159 | 212 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 103 | 104 | 159 | 213 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 103 | 104 | 213 | 232 | 236 | 245 | 248 | 252 | | | |
| 68 | 103 | 104 | 159 | 215 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 103 | 104 | 159 | 216 | 232 | 236 | 245 | 248 | 252 | | |
| 20 | 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 255 | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 256 | | |
| 68 | 103 | 104 | 159 | 232 | 236 | 245 | 248 | 252 | 260 | | |
| 68 | 103 | 104 | 159 | 228 | 232 | 236 | 245 | 248 | 252 | | |
| 68 | 76 | 89 | 103 | 104 | 159 | 210 | 213 | 232 | 236 | 245 | 260 |
| 68 | 103 | 104 | 159 | 218 | 232 | 236 | 245 | 248 | 252 | | |

Still yet an even more preferred protease variant useful in the cleaning composition of the present invention include a substitution set selected from the group consisting of the substitution sets in Table X:

Table X

| | | | | | | | | | | | |
|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| V68A | S103A | V104I | G159D | A228V | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | N218S | A232V | Q236H | Q245R | N248D | N252K | | |
| G20R | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | N76D | E89D | S103A | V104I | G159D | P210L | T213R | A232V | Q236H | Q245R | T260A |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | S256R | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | T260R | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | T255V | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | S256N | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252L | | | |
| V68A | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | A215V | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | A215R | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | S216T | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | S216V | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | T213S | A232V | Q236H | Q245R | N248D | N252K | | | |

| | | | | | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|
| V68A | S103A | V104I | G159D | P210L | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | S212C | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | | |
| S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| V68A | S103A | V104I | G159D | Y209W | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | Q109R | G159D | A232V | Q236H | Q245R | N248D | N252K | | |
| G20R | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | Y209F | A232V | Q236H | Q245R | N248D | N252K | | |
| N76D | S103A | V104I | G159D | Y192F | A232V | Q236H | Q245R | | | | |
| N76D | S103A | V104I | V147I | G159D | A232V | Q236H | Q245R | N248S | K251R | | |
| Q12R | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | A272S | | |
| V68A | N76D | S103A | V104I | G159D | N183K | Q206L | A232V | Q236H | Q245R | | |
| V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | S256R | | | |
| V68A | N76D | S103A | V104I | G159D | Q206R | A232V | Q236H | Q245R | | | |
| K27R | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | | | |
| Q12R | A48V | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | | |
| V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | N261W | | | |
| V68A | N76D | S103A | V104I | G159D | G211R | A232V | Q236H | Q245R | | | |
| V68A | N76D | S103A | V104I | G159D | G211V | A232V | Q236H | Q245R | | | |
| Q12R | V68A | N76D | S103A | V104I | G159D | Y214L | A232V | Q236H | Q245R | | |
| V68A | N76D | S103A | V104I | G159D | A215R | A232V | Q236H | Q245R | | | |
| Q12R | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | | | |
| G20R | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | S259G | | |
| V68A | N76D | S87R | S103A | V104I | G159D | A232V | Q236H | Q245R | T260V | | |
| N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | | | | |
| V68A | N76D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | T260A | | |
| V68A | N76D | S103A | V104I | G159D | P210R | A232V | Q236H | Q245R | | | |
| V68A | S103A | V104I | G159D | S212P | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | T224A | A232V | Q236H | Q245R | L257V | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N252S | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N252K | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | | |
| V68A | S103A | V104I | N140D | G159D | A232V | Q236H | Q245R | N252K | | | |
| N43S | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N252K | | | |
| N43K | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | |

| | | | | | | | | | | | |
|------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|--|
| N43D | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N252K | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | | | | |

A highly preferred protease variant useful in the cleaning compositions of the present invention include a substitution set selected from the group consisting of:

12/102/103/104/159/212/232/236/245/248/252; 61/68/103/104/159/232/236/245/248/252;
62/103/104/130/159/213/232/236/245/248/252; 62/103/104/159/213/232/236/245/248/252;
62/103/104/109/159/213/232/236/245/248/252; 62/103/104/159/232/236/245/248/252;
62/101/103/104/159/212/213/232/236/245/248/252;
68/103/104/159/232/236/245/248/252/270;
68/103/104/159/185/232/236/245/248/252; 68/103/104/159/210/232/236/245/248/252;
68/103/104/159/185/210/232/236/245/248/252; 68/103/104/159/213/232/236/245/248/252;
68/103/104/159/230/232/236/245; 68/76/103/104/159/209/232/236/245;
68/103/104/232/236/245/248/257/275; 68/103/104/213/232/236/245/248/252;
68/103/104/159/232/236/245/248/252; 68/103/104/159/209/232/236/245;
68/76/103/104/159/232/236/245; 68/103/104/159/232/236/245/252;
68/103/104/159/232/236/245; 68/103/104/159/232/236/245/257;
68/76/103/104/159/211/232/236/245; 68/76/103/104/159/215/232/236/245;
68/103/104/159/210/232/236/245; 68/103/104/159/213/232/236/245/260;
68/76/103/104/159/213/232/236/245/260; 68/76/103/104/159/210/232/236/245/260;
68/103/104/159/183/232/236/245/248/252; 68/103/104/232/236/245/257/275;
68/103/104/159/213/232/236/245; 76/103/104/159/232/236/245;
76/103/104/159/213/232/236/245/260; 76/103/104/131/159/232/236/245/248/252;
97/103/104/159/232/236/245/248/252; 98/103/104/159/232/236/245/248/252;
98/102/103/104/159/212/232/236/245/248/252; 101/103/104/159/232/236/245/248/252;
102/103/104/159/232/236/245/248/252; 103/104/159/232/236/245;
103/104/159/248/252/270; 103/104/159/232/236/245/248/252;
103/104/159/205/209/232/236/245/257 103/104/159/232/245/248/252;
103/104/159/205/209/210/232/236/245/257; 103/104/159/213/232/236/245/248/252;
103/104/159/217/232/236/245/248/252; 103/104/130/159/232/236/245/248/252;
103/104/131/159/232/236/245/248/252; 103/104/159/205/209/232/236/245; and
103/104/159/232/236/245/257.

A more highly preferred protease variant useful in the cleaning compositions of the present invention include a substitution set selected from the group consisting of:

12R/102A/103A/104I/159D/212G/232V/236H/245R/248D/252K;
61E/68A/103A/104I/159D/232V/236H/245R/248D/252K;
62D/103A/104I/109R/159D/213R/232V/236H/245R/248D/252K;
62D/103A/104I/159D/213R/232V/236H/245R/248D/252K;
62D/103A/104I/159D/232V/236H/245R/248D/252K;
62D/103A/104I/130G/159D/213R/232V/236H/245R/248D/252K;
62D/101G/103A/104I/159D/212G/213R/232V/236H/245R/248D/252K;
68A/76D/103A/104I/159D/213R/232V/236H/245R/260A;
68A/76D/103A/104I/159D/210I/232V/236H/245R/260A;
68A/103A/104I/159D/183D/232V/236H/245R/248D/252K;
68A/103A/104I/159D/209W/232V/236H/245R;
68A/76D/103A/104I/159D/211R/232V/236H/245R;
68A/76D/103A/104I/159D/215R/232V/236H/245R;
68A/103A/104I/159D/213R/232V/236H/245R/260A;
68A/76D/103A/104I/159D/232V/236H/245R;
68A/103A/104I/159D/232V/236H/245R/252K;
68A/103A/104I/159D/232V/236H/245R;
68A/103A/104I/159D/232V/236H/245R/257V;
68A/103A/104I/159D/185D/232V/236H/245R/248D/252K;
68A/103A/104I/159D/210L/232V/236H/245R/248D/252K;
68A/103A/104I/159D/185D/210L/232V/236H/245R/248D/252K;
68A/103A/104I/159D/213E/232V/236H/245R/248D/252K;
68A/103A/104I/159D/230V/232V/236H/245R;
68A/76D/103A/104I/159D/209W/232V/236H/245R;
68A/103A/104I/232V/236H/245R/248D/257V/275H;
68A/103A/104I/232V/236H/245R/257V/275H;
68A/103A/104I/213E/232V/236H/245R/248D/252K;
68A/103A/104I/159D/232V/236H/245R/248D/252K;
68A/103A/104I/159D/210I/232V/236H/245R;
68A/103A/104I/159D/210L/232V/236H/245R;
68A/103A/104I/159D/213G/232V/236H/245R;
68A/103A/104I/159D/232V/236H/245R/248D/252K/270A;
76D/103A/104I/159D/232V/236H/245R;
76D/103A/104I/131V/159D/232V/236H/245R/248D/252K;
76D/103A/104I/159D/213R/232V/236H/245R/260A;
97E/103A/104I/159D/232V/236H/245R/248D/252K;
98L/103A/104I/159D/232V/236H/245R/248D/252K;

98L/102A/103A/104I/159D/212G/232V/236H/245R/248D/252K;
 101G/103A/104I/159D/232V/236H/245R/248D/252K;
 102A/103A/104I/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/213R/232V/236H/245R/248D/252K;
 103A/104I/130G/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/217E/232V/236H/245R/248D/252K;
 103A/104I/159D/248D/252K/270V;
 103A/104I/159D/232V/236H/245R;
 103A/104I/159D/205I/209W/232V/236H/245R;
 103A/104I/159D/232V/236H/245R/257V;
 103A/104I/159D/205I/209W/232V/236H/245R/257V;
 103A/104I/131V/159D/232V/236H/245R/248D/252K;
 103A/104I/159D/205I/209W/210I/232V/236H/245R/257V; and
 103A/104I/159D/232V/245R/248D/252K.

Recombinant Proteases/Recombinant Subtilisins - A "recombinant protease" or "recombinant subtilisin" refers to a protease or subtilisin in which the DNA sequence encoding the naturally-occurring protease or subtilisin, respectively, is modified to produce a mutant DNA sequence which encodes the substitution, insertion or deletion of one or more amino acids in the protease or subtilisin amino acid sequence. Suitable modification methods are disclosed herein, and in U.S. Patent Nos. RE 34,606, 5,204,015 and 5,185,258.

Non-Human Proteases/Non-Human Subtilisins - "Non-human proteases" or "non-human subtilisins" and the DNA encoding them may be obtained from many procaryotic and eucaryotic organisms. Suitable examples of procaryotic organisms include gram negative organisms such as *E. coli* or *Pseudomonas* and gram positive bacteria such as *Micrococcus* or *Bacillus*. Examples of eucaryotic organisms from which carbonyl hydrolase and their genes may be obtained include yeast such as *Saccharomyces cerevisiae*, fungi such as *Aspergillus* sp. and non-human mammalian sources such as, for example, *bovine* sp. from which the gene encoding the protease chymosin or subtilisin chymosin can be obtained. A series of proteases and/or subtilisins can be obtained from various related species which have amino acid sequences which are not entirely homologous between the members of that series but which nevertheless exhibit the same or similar type of biological activity. Thus, non-human protease or non-human subtilisin as used herein have a functional definition which refers to proteases or subtilisins, respectively, which are associated, directly or indirectly, with procaryotic and eucaryotic sources.

Variant DNA Sequences - Variant DNA sequences encoding such protease or subtilisin variants are derived from a precursor DNA sequence which encodes a naturally-occurring or recombinant precursor enzyme. The variant DNA sequences are derived by modifying the precursor DNA sequence to encode the substitution of one or more specific amino acid residues encoded by the precursor DNA sequence corresponding to positions 103 in combination with one or more of the following positions 1, 3, 4, 8, 10, 12, 13, 15, 16, 17, 18, 20, 21, 22, 24, 25, 27, 33, 37, 38, 42, 43, 48, 55, 57, 61, 62, 68, 72, 75, 76, 77, 78, 79, 86, 87, 89, 97, 98, 99, 101, 102, 104, 106, 107, 109, 111, 114, 115, 116, 117, 119, 121, 123, 128, 130, 131, 133, 134, 137, 140, 141, 142, 146, 147, 158, 159, 160, 161, 166, 167, 170, 173, 174, 177, 181, 182, 183, 184, 185, 188, 192, 194, 198, 203, 204, 205, 206, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 222, 224, 227, 228, 230, 232, 236, 237, 238, 240, 242, 243, 244, 245, 246, 247, 248, 249, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 265, 268, 269, 270, 271, 272, 274 and 275 of *Bacillus amyloliquefaciens* subtilisin; wherein when said protease variant includes a substitution of amino acid residues at positions corresponding to positions 103 and 76, there is also a substitution of an amino acid residue at one or more amino acid residue positions other than amino acid residue positions corresponding to positions 27, 99, 101, 104, 107, 109, 123, 128, 166, 204, 206, 210, 216, 217, 218, 222, 260, 265 or 274 of *Bacillus amyloliquefaciens* subtilisin. Although the amino acid residues identified for modification herein are identified according to the numbering applicable to *B. amyloliquefaciens* (which has become the conventional method for identifying residue positions in all subtilisins), the preferred precursor DNA sequence useful for the present invention is the DNA sequence of *Bacillus lentus* as shown in Fig. 3.

In a preferred embodiment, these variant DNA sequences encode the substitution, insertion or deletion of the amino acid residue corresponding to position 103 of *Bacillus amyloliquefaciens* subtilisin in combination with one or more additional amino acid residues corresponding to positions 1, 3, 4, 8, 9, 10, 12, 13, 16, 17, 18, 19, 20, 21, 22, 24, 27, 33, 37, 38, 42, 43, 48, 55, 57, 58, 61, 62, 68, 72, 75, 76, 77, 78, 79, 86, 87, 89, 97, 98, 99, 101, 102, 104, 106, 107, 109, 111, 114, 116, 117, 119, 121, 123, 126, 128, 130, 131, 133, 134, 137, 140, 141, 142, 146, 147, 158, 159, 160, 166, 167, 170, 173, 174, 177, 181, 182, 183, 184, 185, 188, 192, 194, 198, 203, 204, 205, 206, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 222, 224, 227, 228, 230, 232, 236, 237, 238, 240, 242, 243, 244, 245, 246, 247, 248, 249, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 265, 268, 269, 270, 271, 272, 274 and 275 of *Bacillus amyloliquefaciens* subtilisin; wherein when said protease variant includes a substitution of amino acid residues at positions corresponding to positions 103 and 76, there is also a substitution of an amino acid residue at one or more amino acid residue positions other than amino acid residue positions

corresponding to positions 27, 99, 101, 104, 107, 109, 123, 128, 166, 204, 206, 210, 216, 217, 218, 222, 260, 265 or 274 of *Bacillus amyloliquefaciens* subtilisin. More preferably, these variant DNA sequences encode the protease variants described herein.

In another preferred embodiment, these variant DNA sequences encode the substitution, insertion or deletion of one or more of the amino acid residues corresponding to positions 62, 212, 230, 232, 252 and 257 of *Bacillus amyloliquefaciens* subtilisin. More preferably, these variant DNA sequences encode the protease variants described herein.

Although the amino acid residues identified for modification herein are identified according to the numbering applicable to *B. amyloliquefaciens* (which has become the conventional method for identifying residue positions in all subtilisins), the preferred precursor DNA sequences useful for the present invention is the DNA sequence of *Bacillus lentus* as shown in Fig. 3.

These recombinant DNA sequences encode protease variants having a novel amino acid sequence and, in general, at least one property which is substantially different from the same property of the enzyme encoded by the precursor protease DNA sequence. Such properties include proteolytic activity, substrate specificity, stability, altered pH profile and/or enhanced performance characteristics.

Specific substitutions corresponding to positions 103 in combination with one or more of the following positions 1, 3, 4, 8, 9, 10, 12, 13, 16, 17, 18, 19, 20, 21, 22, 24, 27, 33, 37, 38, 42, 43, 48, 55, 57, 58, 61, 62, 68, 72, 75, 76, 77, 78, 79, 86, 87, 89, 97, 98, 99, 101, 102, 104, 106, 107, 109, 111, 114, 116, 117, 119, 121, 123, 126, 128, 130, 131, 133, 134, 137, 140, 141, 142, 146, 147, 158, 159, 160, 166, 167, 170, 173, 174, 177, 181, 182, 183, 184, 185, 188, 192, 194, 198, 203, 204, 205, 206, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 222, 224, 227, 228, 230, 232, 236, 237, 238, 240, 242, 243, 244, 245, 246, 247, 248, 249, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 265, 268, 269, 270, 271, 272, 274 and 275 of *Bacillus amyloliquefaciens* subtilisin; wherein when said protease variant includes a substitution of amino acid residues at positions corresponding to positions 103 and 76, there is also a substitution of an amino acid residue at one or more amino acid residue positions other than amino acid residue positions corresponding to positions 27, 99, 101, 104, 107, 109, 123, 128, 166, 204, 206, 210, 216, 217, 218, 222, 260, 265 or 274 wherein the numbered positions correspond to the naturally-occurring subtilisin from *Bacillus amyloliquefaciens* or to equivalent amino acid residues in other carbonyl hydrolases or subtilisins (such as *Bacillus lentus* subtilisin) are described herein. Further, specific substitutions corresponding to one or more of the following positions 62, 212, 230, 232, 252 and 257 wherein the numbered positions correspond to the naturally-occurring subtilisin from *Bacillus amyloliquefaciens* or to equivalent amino acid residues in other carbonyl hydrolases or subtilisins (such as *Bacillus lentus* subtilisin) are

described herein. These amino acid position numbers refer to those assigned to the mature *Bacillus amyloliquefaciens* subtilisin sequence presented in Fig. 1. The present invention, however, is not limited to the use of mutation of this particular subtilisin but extends to precursor proteases containing amino acid residues at positions which are "equivalent" to the particular identified residues in *Bacillus amyloliquefaciens* subtilisin. In a preferred embodiment of the present invention, the precursor protease is *Bacillus lentus* subtilisin and the substitutions, deletions or insertions are made at the equivalent amino acid residue in *B. lentus* corresponding to those listed above.

A residue (amino acid) of a precursor protease is equivalent to a residue of *Bacillus amyloliquefaciens* subtilisin if it is either homologous (i.e., corresponding in position in either primary or tertiary structure) or analogous to a specific residue or portion of that residue in *Bacillus amyloliquefaciens* subtilisin (i.e., having the same or similar functional capacity to combine, react or interact chemically).

In order to establish homology to primary structure, the amino acid sequence of a precursor protease is directly compared to the *Bacillus amyloliquefaciens* subtilisin primary sequence and particularly to a set of residues known to be invariant in subtilisins for which sequence is known. For example, Fig. 2 herein shows the conserved residues as between *B. amyloliquefaciens* subtilisin and *B. lentus* subtilisin. After aligning the conserved residues, allowing for necessary insertions and deletions in order to maintain alignment (i.e., avoiding the elimination of conserved residues through arbitrary deletion and insertion), the residues equivalent to particular amino acids in the primary sequence of *Bacillus amyloliquefaciens* subtilisin are defined. Alignment of conserved residues preferably should conserve 100% of such residues. However, alignment of greater than 75% or as little as 50% of conserved residues is also adequate to define equivalent residues. Conservation of the catalytic triad, Asp32/His64/Ser221 should be maintained.

For example, in Fig. 3 the amino acid sequence of subtilisin from *Bacillus amyloliquefaciens*, *Bacillus subtilis*, *Bacillus licheniformis* (carlsbergensis) and *Bacillus lentus* are aligned to provide the maximum amount of homology between amino acid sequences. A comparison of these sequences shows that there are a number of conserved residues contained in each sequence. These conserved residues (as between BPN' and *B. lentus*) are identified in Fig. 2.

These conserved residues, thus, may be used to define the corresponding equivalent amino acid residues of *Bacillus lentus* (PCT Publication No. WO89/06279 published July 13, 1989), the preferred protease precursor enzyme herein, or the subtilisin referred to as PB92 (EP 0 328 299), which is highly homologous to the preferred *Bacillus lentus* subtilisin. The amino acid sequences of certain of these subtilisins are aligned in Figs. 3A and 3B with the sequence of *Bacillus amyloliquefaciens* subtilisin to produce the maximum

homology of conserved residues. As can be seen, there are a number of deletion in the sequence of *Bacillus lentus* as compared to *Bacillus amyloliquefaciens* subtilisin. Thus, for example, the equivalent amino acid for Val165 in *Bacillus amyloliquefaciens* subtilisin in the other subtilisins is isoleucine for *B. lentus* and *B. licheniformis*. Thus, for example, the amino acid at position +76 is asparagine (N) in both *B. amyloliquefaciens* and *B. lentus subtilisins*. In the protease variants of the invention, however, the amino acid equivalent to +76 in *Bacillus amyloliquefaciens* subtilisin is substituted with aspartate (D). The abbreviations and one letter codes for all amino acids in the present invention conform to the Patentin User Manual (GenBank, Mountain View, CA) 1990, p. 101.

"Equivalent residues" may also be defined by determining homology at the level of tertiary structure for a precursor protease whose tertiary structure has been determined by x-ray crystallography. Equivalent residues are defined as those for which the atomic coordinates of two or more of the main chain atoms of a particular amino acid residue of the precursor protease and *Bacillus amyloliquefaciens* subtilisin (N on N, CA on CA, C on C and O on O) are within 0.13nm and preferably 0.1nm after alignment. Alignment is achieved after the best model has been oriented and positioned to give the maximum overlap of atomic coordinates of non-hydrogen protein atoms of the protease in question to the *Bacillus amyloliquefaciens* subtilisin. The best model is the crystallographic model giving the lowest R factor for experimental diffraction data at the highest resolution available.

$$R \text{ factor} = \frac{\sum_h |F_o(h)| - |F_c(h)|}{\sum_h |F_o(h)|}$$

Equivalent residues which are functionally analogues to a specific residue of *Bacillus amyloliquefaciens* subtilisin are defined as those amino acids of the precursor protease which may adopt a conformation such that they either alter, modify or contribute to protein structure, substrate binding or catalysis in a manner defined and attributed to a specific residue of the *Bacillus amyloliquefaciens* subtilisin. Further, they are those residues of the precursor protease (for which a tertiary structure has been obtained by x-ray crystallography) which occupy an analogous position to the extent that, although the main chain atoms of the given residue may not satisfy the criteria of equivalence on the basis of occupying a homologous position, the atomic coordinates of at least two of the side chain atoms of the residue lie within 0.13nm of the corresponding side chain atoms of *Bacillus amyloliquefaciens* subtilisin. The coordinates of the three dimensional structure of *Bacillus amyloliquefaciens* subtilisin are set forth in EPO Publication No. 0 251 446 (equivalent to US Patent 5,182,204, the disclosure of which is incorporated herein by reference) and can be used as outlined above to determine equivalent residues on the level of tertiary structure.

Some of the residues identified for substitution, insertion or deletion are conserved residues whereas others are not. In the case of residues which are not conserved, the replacement of one or more amino acids is limited to substitutions which produce a variant which has an amino acid sequence that does not correspond to one found in nature. In the case of conserved residues, such replacements should not result in natural-occurring sequence. The protease variants of the present invention include the mature forms of protease variants, as well as the pro- and pre-pro-forms of such protease variants. The prepro-forms are the preferred construction since this facilitates the expression, secretion and maturation of the protease variants.

"Prosequence" refers to a sequence of amino acids bound to the N-terminal portion of the mature form of a protease which when removed results in the appearance of the "mature" form of the protease. Many proteolytic enzymes are found in nature as translational proenzyme products and, in the absence of post-translational processing, are expressed in this fashion. A preferred prosequence for producing protease variants is the putative prosequence of *Bacillus amyloliquefaciens* subtilisin, although other protease prosequences may be used.

A "signal sequence" or "presequence" refers to any sequence of amino acids bound to the N-terminal portion of a protease or to the N-terminal portion of a proprotease which may participate in the secretion of the mature or pro forms of the protease. This definition of signal sequence is a functional one, meant to include all those amino sequences encoded by the N-terminal portion of the protease gene which participate in the effectuation of the secretion of protease under native conditions. The present invention utilizes such sequences to effect the secretion of the protease variants as defined here. One possible signal sequence comprises the first seven amino acid residues of the signal sequence from *Bacillus subtilis* subtilisin fused to the remainder of the signal sequence of the subtilisin from *Bacillus lentus* (ATCC 21536).

A "prepro" form of a protease variant consists of the mature form of the protease having a prosequence operably linked to the amino terminus of the protease and a "pre" or "signal" sequence operably linked to the amino terminus of the prosequence.

"Expression vector" refers to a DNA construct containing a DNA sequence which is operably linked to a suitable control sequence capable of effecting the expression of said DNA in a suitable host. Such control sequences include a promoter to effect transcription, an optional operator sequence to control such transcription, a sequence encoding suitable mRNA ribosome binding sites and sequences which control termination of transcription and translation. The vector may be a plasmid, a phage particle, or simply a potential genomic insert. Once transformed into a suitable host, the vector may replicate and function independently or the host genome, or may, in some instances, integrate into the

genome itself. In the present specification, "plasmid" and "vector" are sometimes used interchangeably as the plasmid is the most commonly used form of vector at present. However, the invention is intended to include such other forms of expression vectors which serve equivalent functions and which are, or become, known in the art.

The "host cells" used in the present invention generally are procaryotic or eucaryotic hosts which preferably have been manipulated by the methods disclosed in US Patent RE 34,606 to render them incapable of secreting enzymatically active endoprotease. A preferred host cell for expressing protease is the *Bacillus* strain BG2036 which is deficient in enzymatically active neutral protease and alkaline protease (subtilisin). The construction of strain BG2036 is described in detail in US Patent 5,264,366. Other host cells for expressing protease include *Bacillus subtilis* 168 (also described in US Patent RE 34,606 and US Patent 5,264,366, the disclosure of which are incorporated herein by reference), as well as any suitable *Bacillus* strain such as *B. licheniformis*, *B. lentus*, etc.).

Host cells are transformed or transfected with vectors constructed using recombinant DNA techniques. Such transformed host cells are capable of either replicating vectors encoding the protease variants or expressing the desired protease variant. In the case of vectors which encode the pre- or prepro-form of the protease variant, such variants, when expressed, are typically secreted from the host cell in to the host cell medium.

"Operably linked," when describing the relationship between two DNA regions, simply means that they are functionally related to each other. For example, a prosequence is operably linked to a peptide if it functions as a signal sequence, participating in the secretion of the mature form of the protein most probably involving cleavage of the signal sequence. A promoter is operably linked to a coding sequence if it controls the transcription of the sequence; a ribosome binding site is operably linked to a coding sequence if it is positioned so as to permit translation.

The genes encoding the naturally-occurring precursor protease may be obtained in accord with the general methods known to those skilled in the art. The methods generally comprise synthesizing labeled probes having putative sequences encoding regions of the protease of interest, preparing genomic libraries from organisms expressing the protease, and screening the libraries for the gene of interest by hybridization to the probes. Positively hybridizing clones are then mapped and sequenced.

The cloned protease is then used to transform a host cell in order to express the protease. The protease gene is then ligated into a high copy number plasmid. This plasmid replicates in hosts in the sense that it contains the well-known elements necessary for plasmid replication: a promote operably linked to the gene in question (which may be supplied as the gene's own homologous promoter if it is recognized, i.e. transcribed by the host), a transcription termination and polyadenylation region (necessary for stability of the

mRNA transcribed by the host from the protease gene in certain eucaryotic host cells) which is exogenous or is supplied by the endogenous terminator region of the protease gene and, desirably, a selection gene such as an antibiotic resistance gene that enables continuous cultural maintenance of plasmid-infected host cells by growth in antibiotic-containing media. High copy number plasmids also contain an origin of replication for the host, thereby enabling large numbers of plasmids to be generated in the cytoplasm without chromosomal limitation. However, it is within the scope herein to integrate multiple copies of the protease gene into host genome. This is facilitated by procaryotic and eucaryotic organisms which are particularly susceptible to homologous recombination. The gene can be a natural *B. lentus* gene. Alternatively, a synthetic gene encoding a naturally-occurring or mutant precursor protease may be produced. In such an approach, the DNA and/or amino acid sequence of the precursor protease is determined. Multiple, overlapping synthetic single-stranded DNA fragments are thereafter synthesized, which upon hybridization and ligation produce a synthetic DNA encoding the precursor protease. An example of synthetic gene construction is set forth in Example 3 of US Patent 5,204,105, the disclosure of which is incorporated herein by reference.

Once the naturally-occurring or synthetic precursor protease gene has been cloned, a number of modifications are undertaken to enhance the use of the gene beyond synthesis of the naturally-occurring precursor protease. Such modifications include the production of recombinant proteases as disclosed in US Patent RE 34,606 and EPO Publication No. 0 251 446 and the production of protease variants described herein.

The following cassette mutagenesis method may be used to facilitate the construction of the proteases variants of the present invention, although other methods may be used. First, the naturally-occurring gene encoding the protease is obtained and sequenced in whole or in part. Then the sequence is scanned for a point at which it is desired to make a mutation (deletion, insertion or substitution) of one or more amino acids in the encoded enzyme. The sequences flanking this point are evaluated for the presence of restriction sites for replacing a short segment of the gene with an oligonucleotide pool which, when expressed will encode various mutants. Such restriction sites are preferably unique sites within the protease gene so as to facilitate the replacement of the gene segment. However, any convenient restriction site which is not overly redundant in the protease gene may be used, provided the gene fragments generated by restriction digestion can be reassembled in proper sequence. If restriction sites are not present at locations within a convenient distance from the selected point (from 10 to 15 nucleotides), such sites are generated by substituting nucleotides in the gene in such fashion that neither the reading frame nor the amino acids encoded are changed in the final construction. Mutation of the gene in order to change its sequence to conform to the desired sequence is accomplished by

M13 primer extension in accord with generally known methods. The task of locating suitable flanking regions and evaluating the needed changes to arrive at two convenient restriction site sequences is made routine by the redundancy of the genetic code, a restriction enzyme map of the gene and the large number of different restriction enzymes. Note that if a convenient flanking restriction site is available, the above method need be used only in connection with the flanking region which does not contain a site.

Once the naturally-occurring DNA or synthetic DNA is cloned, the restriction sites flanking the positions to be mutated are digested with the cognate restriction enzymes and a plurality of end termini-complementary oligonucleotide cassettes are ligated into the gene. The mutagenesis is simplified by this method because all of the oligonucleotides can be synthesized so as to have the same restriction sites, and no synthetic linkers are necessary to create the restriction sites. As used herein, proteolytic activity is defined as the rate of hydrolysis of peptide bonds per milligram of active enzyme. Many well known procedures exist for measuring proteolytic activity (K. M. Kalisz, "Microbial Proteinases," Advances in Biochemical Engineering/Biotechnology, A. Fiechter ed., 1988). In addition to or as an alternative to modified proteolytic activity, the variant enzymes of the present invention may have other modified properties such as K_m , k_{cat} , k_{cat}/K_m ratio and/or modified substrate specificity and/or modified pH activity profile. These enzymes can be tailored for the particular substrate which is anticipated to be present, for example, in the preparation of peptides or for hydrolytic processes such as laundry uses.

In one aspect of the invention, the objective is to secure a variant protease having altered proteolytic activity as compared to the precursor protease, since increasing such activity (numerically larger) enables the use of the enzyme to more efficiently act on a target substrate. Also of interest are variant enzymes having altered thermal stability and/or altered substrate specificity as compared to the precursor. In some instances, lower proteolytic activity may be desirable, for example a decrease in proteolytic activity would be useful where the synthetic activity of the proteases is desired (as for synthesizing peptides). One may wish to decrease this proteolytic activity, which is capable of destroying the product of such synthesis. Conversely, in some instances it may be desirable to increase the proteolytic activity of the variant enzyme versus its precursor. Additionally, increases or decreases (alteration) of the stability of the variant, whether alkaline or thermal stability, may be desirable. Increases or decreases in k_{cat} , K_m or K_{cat}/K_m are specific to the substrate used to determine these kinetic parameters.

In another aspect of the invention, it has been determined that substitutions at positions corresponding to 103 in combination with one or more of the following positions 1, 3, 4, 8, 9, 10, 12, 13, 16, 17, 18, 19, 20, 21, 22, 24, 27, 33, 37, 38, 42, 43, 48, 55, 57, 58, 61, 62, 68, 72, 75, 76, 77, 78, 79, 86, 87, 89, 97, 98, 99, 101, 102, 104, 106, 107, 109, 111,

114, 116, 117, 119, 121, 123, 126, 128, 130, 131, 133, 134, 137, 140, 141, 142, 146, 147, 158, 159, 160, 166, 167, 170, 173, 174, 177, 181, 182, 183, 184, 185, 188, 192, 194, 198, 203, 204, 205, 206, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 222, 224, 227, 228, 230, 232, 236, 237, 238, 240, 242, 243, 244, 245, 246, 247, 248, 249, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 265, 268, 269, 270, 271, 272, 274 and 275 of *Bacillus amyloliquefaciens* subtilisin are important in modulating overall stability and/or proteolytic activity of the enzyme.

In a further aspect of the invention, it has been determined that substitutions at one or more of the following positions corresponding to positions 62, 212, 230, 232, 252 and 257 of *Bacillus amyloliquefaciens* subtilisin are also important in modulating overall stability and/or proteolytic activity of the enzyme.

These substitutions are preferably made in *Bacillus lentus* (recombinant or native-type) subtilisin, although the substitutions may be made in any *Bacillus* protease.

Based on the screening results obtained with the variant proteases, the noted mutations in *Bacillus amyloliquefaciens* subtilisin are important to the proteolytic activity, performance and/or stability of these enzymes and the cleaning or wash performance of such variant enzymes.

Methods and procedures for making the enzymes used in the detergent and cleaning compositions of the present invention are known and are disclosed in PCT Publication No. WO 95/10615.

The enzymes of the present invention have trypsin-like specificity. That is, the enzymes of the present invention hydrolyze proteins by preferentially cleaving the peptide bonds of charged amino acid residues, more specifically residues such as arginine and lysine, rather than preferentially cleaving the peptide bonds of hydrophobic amino acid residues, more specifically phenylalanine, tryptophan and tyrosine. Enzymes having the latter profile have a chymotrypsin-like specificity. Substrate specificity as discussed above is illustrated by the action of the enzyme on two synthetic substrates. Protease's having trypsin-like specificity hydrolyze the synthetic substrate bVGR-pNA preferentially over the synthetic substrate sucAAPF-pNA. Chymotrypsin-like protease enzymes, in contrast, hydrolyze the latter much faster than the former. For the purposes of the present invention the following procedure was employed to define the trypsin-like specificity of the protease enzymes of the present invention:

A fixed amount of a glycine buffer at a pH of 10 and a temperature of 25 °C is added to a standard 10 ml test tube. 0.5 ppm of the active enzyme to be tested is added to the test tube. Approximately, 1.25 mg of the synthetic substrate per mL of buffer solution is added to the test tube. The mixture is allowed to incubate for 15 minutes at 25 °C. Upon completion of the incubation period, an enzyme inhibitor, PMSF, is added to the mixture at

a level of 0.5 mg per mL of buffer solution. The absorbency or OD value of the mixture is read at a 410 nm wavelength. The absorbence then indicates the activity of the enzyme on the synthetic substrate. The greater the absorbence, the higher the level of activity against that substrate.

To then determine the specificity of an individual enzyme, the absorbence on the two synthetic substrate proteins may be converted into a specificity ratio. For the purposes of the present invention, the ratio is determined by the formula specificity of:

$$[\text{activity on sAAPF-pNA}]/[\text{activity on bVGR-pNA}]$$

An enzyme having a ratio of less than about 10, more preferably less than about 5 and most preferably less than about 2.5 may then be considered to demonstrate trypsin-like activity.

Such variants generally have at least one property which is different from the same property of the protease precursor from which the amino acid sequence of the variant is derived.

One aspect of the invention are compositions, such as detergent and cleaning compositions, for the treatment of textiles, dishware, tableware, kitchenware, cookware, and other hard surface substrates that include one or more of the variant proteases of the present invention. Protease-containing compositions can be used to treat for example: silk or wool, as well as other types of fabrics, as described in publications such as RD 216,034, EP 134,267, US 4,533,359, and EP 344,259; and dishware, tableware, kitchenware, cookware, and other hard surface substrates as described in publications such as in US 5,478,742, US 5,346,822, US 5,679,630, and US 5,677,272.

II. Amylase Variants - The amylase variants used in the present invention include, but are not limited to, the amylase enzymes described in WO 95/26397 and in WO 96/23873 (Novo). These enzymes are incorporated into cleaning compositions at a level of from about 0.0001%, preferably from about 0.00018%, more preferably from about 0.00024%, most preferably from about 0.05% to about 0.1%, preferably to about 0.060%, more preferably to about 0.048% by weight of the cleaning compositions of pure enzyme.

The amylase variants are preferably selected from the group consisting of α -amylase variants.

Suitable α -amylase variants for use in the present invention include, but are not limited to the following α -amylases:

(i) α -amylase characterized by having a specific activity at least 25% higher than the specific activity of Termamyl[®] at a temperature range of 25°C to 55°C and at a pH value in the range of 8 to 10, measured by Phadebas[®] α -amylase activity assay and/or;

(ii) α -amylase according to (i) comprising the amino acid sequence shown in SEQ ID No. 1 or an α -amylase being at least 80% homologous with the amino acid sequence shown in SEQ ID No. 1 and/or;

(iii) α -amylase according to (i) comprising the amino acid sequence shown in SEQ ID No. 2 or an α -amylase being at least 80% homologous with the amino acid sequence shown in SEQ ID No. 2 and/or;

(iv) α -amylase according to (i) comprising the following amino acid sequence N-terminal: His-His-Asn-Gly-Thr-Asn-Gly-Thr-Met-Met-Gln-Tyr-Phe-Glu-Trp-Tyr-Leu-Pro-Asn-Asp (SEQ ID No. 3) or an α -amylase being at least 80% homologous with the amino acid sequence shown (SEQ ID No. 3) in the N-terminal and/or;

(v) α -amylase according to (i-iv) wherein the α -amylase is obtainable from an alkalophilic *Bacillus* species and/or;

(vi) α -amylase according to (v) wherein the amylase is obtainable from any of the strains NCIB 12289, NCIB 12512, NCIB 12513 and DSM 935 and/or;

(vii) α -amylase showing positive immunological cross-reactivity with antibodies raised against an α -amylase having an amino acid sequence corresponding respectively to SEQ ID No. 1, ID No. 2, or ID No. 3 and/or;

(viii) variant of a parent α -amylase, wherein the parent α -amylase (1) has one of the amino acid sequences shown in SEQ ID No. 1, ID No. 2, or ID No. 4, respectively, or (2) displays at least 80% homology with one or more of said amino acid sequences, and/or displays immunological cross-reactivity with an antibody raised against an α -amylase having one of said amino acid sequences, and/or is encoded by a DNA sequence which hybridizes with the same probe as a DNA sequence encoding an α -amylase having one of said amino acid sequences, in which variants: (A) at least one amino acid residue of said parent α -amylase has been deleted; and/or (B) at least one amino acid residue of said parent α -amylase has been replaced by a different amino acid residue; and/or (C) at least one amino acid residue has been inserted relative to said parent α -amylase; said variant having an α -amylase activity and exhibiting at least one of the following properties relative to said parent α -amylase: increased thermostability; increased stability towards oxidation; reduced Ca ion dependency; increased stability and/or α -amylolytic activity at neutral to relatively high pH values; increased α -amylolytic activity at relatively high temperature; and increase or decrease of the isoelectric point (pI) so as to better match the pI value for α -amylase variant to the pH of the medium.

A polypeptide is considered to be X% homologous to the parent amylase if a comparison of the respective amino acid sequences, performed via algorithms, such as the one described by Lipman and Pearson in Science 227, 1985, p. 1435, reveals an identity of X%.

In the context of the present invention, the term "obtainable from" is intended not only to indicate an amylase produced by a *Bacillus* strain but also an amylase encoded by a DNA sequence isolated from such a *Bacillus* strain and produced in a host organism transformed with the DNA sequence.

III. Protease/Amylase Combination - Although any one or more of the protease variants described above can be combined with one or more of the amylase variants described above, in a highly preferred embodiment of the present invention, the protease variant comprises the substitution set: 101/103/104/159/232/236/245/248/252, and more highly preferred the substitution set: 101G/103A/104I/232V/236H/245R/248D/252K.

Although the protease variant and amylase variant can be present in the cleaning compositions in any ratio by ppm, a preferred ratio of protease variant(s) to amylase variant(s) by ppm in the cleaning compositions of the present invention are in the range of from about 1:20 to about 20:1, preferably from about 1:10 to about 10:1, more preferably from about 1:3 to about 3:1.

CLEANING COMPOSITIONS

The cleaning compositions of the present invention also comprise, in addition to one or more protease variants described hereinbefore, one or more cleaning adjunct materials, preferably compatible with the protease variant(s). The term "cleaning adjunct materials", as used herein, means any liquid, solid or gaseous material selected for the particular type of cleaning composition desired and the form of the product (e.g., liquid; granule; powder; bar; paste; spray; tablet; gel; foam composition), which materials are also preferably compatible with the protease enzyme used in the composition. Granular compositions can also be in "compact" form and the liquid compositions can also be in a "concentrated" form.

The specific selection of cleaning adjunct materials are readily made by considering the surface, item or fabric to be cleaned, and the desired form of the composition for the cleaning conditions during use (e.g., through the wash detergent use). The term "compatible", as used herein, means the cleaning composition materials do not reduce the proteolytic activity of the protease enzyme to such an extent that the protease is not effective as desired during normal use situations. Examples of suitable cleaning adjunct materials include, but are not limited to, surfactants, builders, bleaches, bleach activators, bleach catalysts, other enzymes, enzyme stabilizing systems, chelants, optical brighteners, soil release polymers, dye transfer agents, dispersants, suds suppressors, dyes, perfumes, colorants, filler salts, hydrotropes, photoactivators, fluorescers, fabric conditioners, hydrolyzable surfactants, preservatives, anti-oxidants, anti-shrinkage agents, anti-wrinkle agents, germicides, fungicides, color speckles, silvercare, anti-tarnish and/or anti-corrosion agents, alkalinity sources, solubilizing agents, carriers, processing aids,

pigments and pH control agents as described in U.S. Patent Nos. 5,705,464, 5,710,115, 5,698,504, 5,695,679, 5,686,014 and 5,646,101. Specific cleaning composition materials are exemplified in detail hereinafter.

If the cleaning adjunct materials are not compatible with the protease variant(s) in the cleaning compositions, then suitable methods of keeping the cleaning adjunct materials and the protease variant(s) separate (not in contact with each other) until combination of the two components is appropriate can be used. Suitable methods can be any method known in the art, such as gelcaps, encapsulation, tablets, physical separation, etc.

Preferably an effective amount of one or more protease variants described above are included in compositions useful for cleaning a variety of surfaces in need of proteinaceous stain removal. Such cleaning compositions include detergent compositions for cleaning hard surfaces, unlimited in form (e.g., liquid and granular); detergent compositions for cleaning fabrics, unlimited in form (e.g., granular, liquid and bar formulations); dishwashing compositions (unlimited in form and including both granular and liquid automatic dishwashing); oral cleaning compositions, unlimited in form (e.g., dentifrice, toothpaste and mouthwash formulations); and denture cleaning compositions, unlimited in form (e.g., liquid, tablet).

As used herein, "effective amount of protease variant" refers to the quantity of protease variant described hereinbefore necessary to achieve the enzymatic activity necessary in the specific cleaning composition. Such effective amounts are readily ascertained by one of ordinary skill in the art and is based on many factors, such as the particular variant used, the cleaning application, the specific composition of the cleaning composition, and whether a liquid or dry (e.g., granular, bar) composition is required, and the like.

Preferably the cleaning compositions comprise from about 0.0001%, preferably from about 0.001%, more preferably from about 0.01% by weight of the cleaning compositions of one or more protease variants of the present invention, to about 10%, preferably to about 1%, more preferably to about 0.1%. Also preferably the protease variant of the present invention is present in the compositions in an amount sufficient to provide a ratio of mg of active protease per 100 grams of composition to ppm theoretical Available O₂ ("AvO₂") from any peroxyacid in the wash liquor, referred to herein as the Enzyme to Bleach ratio (E/B ratio), ranging from about 1:1 to about 20:1. Several examples of various cleaning compositions wherein the protease variants of the present invention may be employed are discussed in further detail below. Also, the cleaning compositions may include from about 1% to about 99.9% by weight of the composition of the cleaning adjunct materials.

The cleaning compositions of the present invention may be in the form of "fabric cleaning compositions" or "non-fabric cleaning compositions."

As used herein, "fabric cleaning compositions" include hand and machine laundry detergent compositions including laundry additive compositions and compositions suitable for use in the soaking and/or pretreatment of stained fabrics.

As used herein, "non-fabric cleaning compositions" include hard surface cleaning compositions, dishwashing detergent compositions, oral cleaning compositions, denture cleaning compositions and personal cleansing compositions.

When the cleaning compositions of the present invention are formulated as compositions suitable for use in a laundry machine washing method, the compositions of the present invention preferably contain both a surfactant and a builder compound and additionally one or more cleaning adjunct materials preferably selected from organic polymeric compounds, bleaching agents, additional enzymes, suds suppressors, dispersants, lime-soap dispersants, soil suspension and anti-redeposition agents and corrosion inhibitors. Laundry compositions can also contain softening agents, as additional cleaning adjunct materials.

The compositions of the present invention can also be used as detergent additive products in solid or liquid form. Such additive products are intended to supplement or boost the performance of conventional detergent compositions and can be added at any stage of the cleaning process.

When formulated as compositions for use in manual dishwashing methods the compositions of the invention preferably contain a surfactant and preferably other cleaning adjunct materials selected from organic polymeric compounds, suds enhancing agents, group II metal ions, solvents, hydrotropes and additional enzymes.

If needed the density of the laundry detergent compositions herein ranges from 400 to 1200 g/litre, preferably 500 to 950 g/litre of composition measured at 20°C.

The "compact" form of the cleaning compositions herein is best reflected by density and, in terms of composition, by the amount of inorganic filler salt; inorganic filler salts are conventional ingredients of detergent compositions in powder form; in conventional detergent compositions, the filler salts are present in substantial amounts, typically 17-35% by weight of the total composition. In the compact compositions, the filler salt is present in amounts not exceeding 15% of the total composition, preferably not exceeding 10%, most preferably not exceeding 5% by weight of the composition. The inorganic filler salts, such as meant in the present compositions are selected from the alkali and alkaline-earth-metal salts of sulfates and chlorides. A preferred filler salt is sodium sulfate.

Liquid cleaning compositions according to the present invention can also be in a "concentrated form", in such case, the liquid cleaning compositions according the present invention will contain a lower amount of water, compared to conventional liquid detergents. Typically the water content of the concentrated liquid cleaning composition is preferably less than 40%, more preferably less than 30%, most preferably less than 20% by weight of the cleaning composition.

Cleaning Adjunct Materials

Surfactant System - Detergent surfactants included in the fully-formulated cleaning compositions afforded by the present invention comprises at least 0.01%, preferably at least about 0.1%, more preferably at least about 0.5%, most preferably at least about 1% to about 60%, more preferably to about 35%, most preferably to about 30% by weight of cleaning composition depending upon the particular surfactants used and the desired effects.

The detergent surfactant can be nonionic, anionic, ampholytic, zwitterionic, cationic, semi-polar nonionic, and mixtures thereof, nonlimiting examples of which are disclosed in U.S. Patent Nos. 5,707,950 and 5,576,282. Preferred detergent and cleaning compositions comprise anionic detergent surfactants or mixtures of anionic surfactants with other surfactants, especially nonionic surfactants.

Nonlimiting examples of surfactants useful herein include the conventional C₁₁-C₁₈ alkyl benzene sulfonates and primary, secondary and random alkyl sulfates, the C₁₀-C₁₈ alkyl alkoxy sulfates, the C₁₀-C₁₈ alkyl polyglycosides and their corresponding sulfated polyglycosides, C₁₂-C₁₈ alpha-sulfonated fatty acid esters, C₁₂-C₁₈ alkyl and alkyl phenol alkoxylates (especially ethoxylates and mixed ethoxy/propoxy), C₁₂-C₁₈ betaines and sulfobetaines ("sultaines"), C₁₀-C₁₈ amine oxides, and the like. Other conventional useful surfactants are listed in standard texts.

The surfactant is preferably formulated to be compatible with enzyme components present in the composition. In liquid or gel compositions the surfactant is most preferably formulated such that it promotes, or at least does not degrade, the stability of any enzyme in these compositions.

Nonionic Surfactants - Polyethylene, polypropylene, and polybutylene oxide condensates of alkyl phenols are suitable for use as the nonionic surfactant of the surfactant systems of the present invention, with the polyethylene oxide condensates being preferred. Commercially available nonionic surfactants of this type include IgepalTM CO-630, marketed by the GAF Corporation; and TritonTM X-45, X-114, X-100 and X-102, all marketed by the Rohm & Haas Company. These surfactants are commonly referred to as alkylphenol alkoxylates (e.g., alkyl phenol ethoxylates).

The condensation products of primary and secondary aliphatic alcohols with from about 1 to about 25 moles of ethylene oxide are suitable for use as the nonionic surfactant

of the nonionic surfactant systems of the present invention. Examples of commercially available nonionic surfactants of this type include TergitolTM 15-S-9 (the condensation product of C₁₁-C₁₅ linear alcohol with 9 moles ethylene oxide), TergitolTM 24-L-6 NMW (the condensation product of C₁₂-C₁₄ primary alcohol with 6 moles ethylene oxide with a narrow molecular weight distribution), both marketed by Union Carbide Corporation; NeodolTM 45-9 (the condensation product of C₁₄-C₁₅ linear alcohol with 9 moles of ethylene oxide), NeodolTM 23-3 (the condensation product of C₁₂-C₁₃ linear alcohol with 3.0 moles of ethylene oxide), NeodolTM 45-7 (the condensation product of C₁₄-C₁₅ linear alcohol with 7 moles of ethylene oxide), NeodolTM 45-5 (the condensation product of C₁₄-C₁₅ linear alcohol with 5 moles of ethylene oxide) marketed by Shell Chemical Company, KyroTM EOB (the condensation product of C₁₃-C₁₅ alcohol with 9 moles ethylene oxide), marketed by The Procter & Gamble Company, and Genapol LA O3O or O5O (the condensation product of C₁₂-C₁₄ alcohol with 3 or 5 moles of ethylene oxide) marketed by Hoechst. Preferred range of HLB in these products is from 8-11 and most preferred from 8-10.

Also useful as the nonionic surfactant of the surfactant systems of the present invention are the alkylpolysaccharides disclosed in U.S. Patent No. 4,565,647.

Preferred alkylpolyglycosides have the formula: $R^2O(C_nH_{2n}O)_t(\text{glycosyl})_x$ wherein R² is selected from the group consisting of alkyl, alkylphenyl, hydroxyalkyl, hydroxyalkylphenyl, and mixtures thereof in which the alkyl groups contain from about 10 to about 18, preferably from about 12 to about 14, carbon atoms; n is 2 or 3, preferably 2; t is from 0 to about 10, preferably 0; and x is from about 1.3 to about 10, preferably from about 1.3 to about 3, most preferably from about 1.3 to about 2.7.

The condensation products of ethylene oxide with a hydrophobic base formed by the condensation of propylene oxide with propylene glycol are also suitable for use as the additional nonionic surfactant systems of the present invention. Examples of compounds of this type include certain of the commercially-available PlurafacTM LF404 and PluronicTM surfactants, marketed by BASF.

Also suitable for use as the nonionic surfactant of the nonionic surfactant system of the present invention, are the condensation products of ethylene oxide with the product resulting from the reaction of propylene oxide and ethylenediamine. Examples of this type of nonionic surfactant include certain of the commercially available TetronicTM compounds, marketed by BASF.

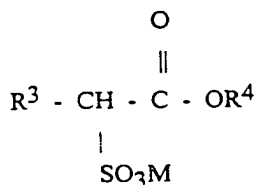
Preferred for use as the nonionic surfactant of the surfactant systems of the present invention are polyethylene oxide condensates of alkyl phenols, condensation products of primary and secondary aliphatic alcohols with from about 1 to about 25 moles of ethylene oxide, alkylpolysaccharides, and mixtures thereof. Most preferred are C₈-C₁₄ alkyl phenol

ethoxylates having from 3 to 15 ethoxy groups and C₈-C₁₈ alcohol ethoxylates (preferably C₁₀ avg.) having from 2 to 10 ethoxy groups, and mixtures thereof.

Highly preferred nonionic surfactants are polyhydroxy fatty acid amide surfactants of the formula: R² - C(O) - N(R¹) - Z wherein R¹ is H, or R¹ is C₁₋₄ hydrocarbyl, 2-hydroxy ethyl, 2-hydroxy propyl or a mixture thereof, R² is C₅₋₃₁ hydrocarbyl, and Z is a polyhydroxyhydrocarbyl having a linear hydrocarbyl chain with at least 3 hydroxyls directly connected to the chain, or an alkoxylated derivative thereof. Preferably, R¹ is methyl, R² is a straight C₁₁₋₁₅ alkyl or C₁₆₋₁₈ alkyl or alkenyl chain such as coconut alkyl or mixtures thereof, and Z is derived from a reducing sugar such as glucose, fructose, maltose, lactose, in a reductive amination reaction.

Anionic Surfactants - Suitable anionic surfactants to be used are linear alkyl benzene sulfonate, alkyl ester sulfonate surfactants including linear esters of C₈-C₂₀ carboxylic acids (i.e., fatty acids) which are sulfonated with gaseous SO₃ according to "The Journal of the American Oil Chemists Society", 52 (1975), pp. 323-329. Suitable starting materials would include natural fatty substances as derived from tallow, palm oil, etc.

The preferred alkyl ester sulfonate surfactant, especially for laundry applications, comprise alkyl ester sulfonate surfactants of the structural formula :



wherein R³ is a C₈-C₂₀ hydrocarbyl, preferably an alkyl, or combination thereof, R⁴ is a C₁-C₆ hydrocarbyl, preferably an alkyl, or combination thereof, and M is a cation which forms a water soluble salt with the alkyl ester sulfonate. Suitable salt-forming cations include metals such as sodium, potassium, and lithium, and substituted or unsubstituted ammonium cations, such as monoethanolamine, diethanolamine, and triethanolamine. Preferably, R³ is C₁₀-C₁₆ alkyl, and R⁴ is methyl, ethyl or isopropyl. Especially preferred are the methyl ester sulfonates wherein R³ is C₁₀-C₁₆ alkyl.

Other suitable anionic surfactants include the alkyl sulfate surfactants which are water soluble salts or acids of the formula ROSO₃M wherein R preferably is a C₁₀-C₂₄ hydrocarbyl, preferably an alkyl or hydroxyalkyl having a C₁₀-C₂₀ alkyl component, more preferably a C₁₂-C₁₈ alkyl or hydroxyalkyl, and M is H or a cation. Typically, alkyl chains of C₁₂-C₁₆ are preferred for lower wash temperatures (e.g. below about 50°C) and C₁₆-18 alkyl chains are preferred for higher wash temperatures (e.g. above about 50°C).

Other anionic surfactants useful for deterative purposes include salts of soap, C₈-C₂₂ primary or secondary alkanesulfonates, C₈-C₂₄ olefinsulfonates, sulfonated

polycarboxylic acids prepared by sulfonation of the pyrolyzed product of alkaline earth metal citrates, e.g., as described in British patent specification No. 1,082,179, C₈-C₂₄ alkylpolyglycolethersulfates (containing up to 10 moles of ethylene oxide); alkyl glycerol sulfonates, fatty acyl glycerol sulfonates, fatty oleyl glycerol sulfates, alkyl phenol ethylene oxide ether sulfates, paraffin sulfonates, alkyl phosphates, isethionates such as the acyl isethionates, N-acyl taurates, alkyl succinamates and sulfosuccinates, monoesters of sulfosuccinates (especially saturated and unsaturated C₁₂-C₁₈ monoesters) and diesters of sulfosuccinates (especially saturated and unsaturated C₆-C₁₂ diesters), acyl sarcosinates, sulfates of alkylpolysaccharides such as the sulfates of alkylpolyglucoside (the nonionic nonsulfated compounds being described below), branched primary alkyl sulfates, and alkyl polyethoxy carboxylates such as those of the formula RO(CH₂CH₂O)_k-CH₂COO-M⁺ wherein R is a C₈-C₂₂ alkyl, k is an integer from 1 to 10, and M is a soluble salt-forming cation. Resin acids and hydrogenated resin acids are also suitable, such as rosin, hydrogenated rosin, and resin acids and hydrogenated resin acids present in or derived from tall oil.

Further examples are described in "Surface Active Agents and Detergents" (Vol. I and II by Schwartz, Perry and Berch). A variety of such surfactants are also generally disclosed in U.S. Patent 3,929,678, issued December 30, 1975 to Laughlin, et al. at Column 23, line 58 through Column 29, line 23 (herein incorporated by reference).

Highly preferred anionic surfactants include alkyl alkoxylated sulfate surfactants hereof are water soluble salts or acids of the formula RO(A)_mSO₃M wherein R is an unsubstituted C₁₀-C₂₄ alkyl or hydroxyalkyl group having a C₁₀-C₂₄ alkyl component, preferably a C₁₂-C₂₀ alkyl or hydroxyalkyl, more preferably C₁₂-C₁₈ alkyl or hydroxyalkyl, A is an ethoxy or propoxy unit, m is greater than zero, typically between about 0.5 and about 6, more preferably between about 0.5 and about 3, and M is H or a cation which can be, for example, a metal cation (e.g., sodium, potassium, lithium, calcium, magnesium, etc.), ammonium or substituted-ammonium cation. Alkyl ethoxylated sulfates as well as alkyl propoxylated sulfates are contemplated herein. Specific examples of substituted ammonium cations include methyl-, dimethyl-, trimethyl-ammonium cations and quaternary ammonium cations such as tetramethyl-ammonium and dimethyl piperdinium cations and those derived from alkylamines such as ethylamine, diethylamine, triethylamine, mixtures thereof, and the like. Exemplary surfactants are C₁₂-C₁₈ alkyl polyethoxylate (1.0) sulfate (C₁₂-C₁₈E(1.0)M), C₁₂-C₁₈ alkyl polyethoxylate (2.25) sulfate (C₁₂-C₁₈E(2.25)M), C₁₂-C₁₈ alkyl polyethoxylate (3.0) sulfate (C₁₂-C₁₈E(3.0)M), and C₁₂-C₁₈ alkyl polyethoxylate (4.0) sulfate (C₁₂-C₁₈E(4.0)M), wherein M is conveniently selected from sodium and potassium.

When included therein, the cleaning compositions of the present invention typically comprise from about 1%, preferably from about 3% to about 40%, preferably about 20% by weight of such anionic surfactants.

Cationic Surfactants - Cationic deterative surfactants suitable for use in the cleaning compositions of the present invention are those having one long-chain hydrocarbyl group. Examples of such cationic surfactants include the ammonium surfactants such as alkyltrimethylammonium halogenides, and those surfactants having the formula: $[R^2(OR^3)_y][R^4(OR^3)_y]_2R^5N^+X^-$ wherein R^2 is an alkyl or alkyl benzyl group having from about 8 to about 18 carbon atoms in the alkyl chain, each R^3 is selected from the group consisting of $-CH_2CH_2-$, $-CH_2CH(CH_3)-$, $-CH_2CH(CH_2OH)-$, $-CH_2CH_2CH_2-$, and mixtures thereof; each R^4 is selected from the group consisting of C_1 - C_4 alkyl, C_1 - C_4 hydroxyalkyl, benzyl ring structures formed by joining the two R^4 groups, $-CH_2CHOH-CHOHCOR^6CHOHCH_2OH$ wherein R^6 is any hexose or hexose polymer having a molecular weight less than about 1000, and hydrogen when y is not 0; R^5 is the same as R^4 or is an alkyl chain wherein the total number of carbon atoms of R^2 plus R^5 is not more than about 18; each y is from 0 to about 10 and the sum of the y values is from 0 to about 15; and X is any compatible anion.

Highly preferred cationic surfactants are the water-soluble quaternary ammonium compounds useful in the present composition having the formula (i): $R_1R_2R_3R_4N^+X^-$ wherein R_1 is C_8 - C_{16} alkyl, each of R_2 , R_3 and R_4 is independently C_1 - C_4 alkyl, C_1 - C_4 hydroxy alkyl, benzyl, and $-(C_2H_4O)_xH$ where x has a value from 2 to 5, and X is an anion. Not more than one of R_2 , R_3 or R_4 should be benzyl. The preferred alkyl chain length for R_1 is C_{12} - C_{15} particularly where the alkyl group is a mixture of chain lengths derived from coconut or palm kernel fat or is derived synthetically by olefin build up or OXO alcohols synthesis. Preferred groups for R_2R_3 and R_4 are methyl and hydroxyethyl groups and the anion X may be selected from halide, methosulfate, acetate and phosphate ions.

Examples of suitable quaternary ammonium compounds of formulae (i) for use herein are include, but are not limited to: coconut trimethyl ammonium chloride or bromide; coconut methyl dihydroxyethyl ammonium chloride or bromide; decyl triethyl ammonium chloride; decyl dimethyl hydroxyethyl ammonium chloride or bromide; C_{12} - C_{15} dimethyl hydroxyethyl ammonium chloride or bromide; coconut dimethyl hydroxyethyl ammonium chloride or bromide; myristyl trimethyl ammonium methyl sulphate; lauryl dimethyl benzyl ammonium chloride or bromide; lauryl dimethyl (ethenoxy)₄ ammonium chloride or bromide; choline esters (compounds of formula (i) wherein R_1 is $CH_2-CH_2-O-C-C_{12-14}$ alkyl and $R_2R_3R_4$ are methyl); and di-alkyl imidazolines [(i)].

Other cationic surfactants useful herein are also described in U.S. Patent 4,228,044, Cambre, issued October 14, 1980 and in European Patent Application EP 000,224.

When included therein, the cleaning compositions of the present invention typically comprise from about 0.2%, preferably from about 1% to about 25%, preferably to about 8% by weight of such cationic surfactants.

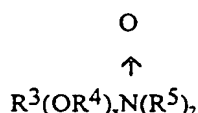
Ampholytic Surfactants - Ampholytic surfactants, examples of which are described in U.S. Patent No. 3,929,678, are also suitable for use in the cleaning compositions of the present invention.

When included therein, the cleaning compositions of the present invention typically comprise from about 0.2%, preferably from about 1% to about 15%, preferably to about 10% by weight of such ampholytic surfactants.

Zwitterionic Surfactants - Zwitterionic surfactants, examples of which are described in U.S. Patent No. 3,929,678, are also suitable for use in cleaning compositions.

When included therein, the cleaning compositions of the present invention typically comprise from about 0.2%, preferably from about 1% to about 15%, preferably to about 10% by weight of such zwitterionic surfactants.

Semi-polar Nonionic Surfactants - Semi-polar nonionic surfactants are a special category of nonionic surfactants which include water-soluble amine oxides having the formula:



wherein R^3 is an alkyl, hydroxyalkyl, or alkyl phenyl group or mixtures thereof containing from about 8 to about 22 carbon atoms; R^4 is an alkylene or hydroxyalkylene group containing from about 2 to about 3 carbon atoms or mixtures thereof; x is from 0 to about 3; and each R^5 is an alkyl or hydroxyalkyl group containing from about 1 to about 3 carbon atoms or a polyethylene oxide group containing from about 1 to about 3 ethylene oxide groups (the R^5 groups can be attached to each other, e.g., through an oxygen or nitrogen atom, to form a ring structure); water-soluble phosphine oxides containing one alkyl moiety of from about 10 to about 18 carbon atoms and 2 moieties selected from the group consisting of alkyl groups and hydroxyalkyl groups containing from about 1 to about 3 carbon atoms; and water-soluble sulfoxides containing one alkyl moiety of from about 10 to about 18 carbon atoms and a moiety selected from the group consisting of alkyl and hydroxyalkyl moieties of from about 1 to about 3 carbon atoms.

The amine oxide surfactants in particular include C_{10} - C_{18} alkyl dimethyl amine oxides and C_8 - C_{12} alkoxy ethyl dihydroxy ethyl amine oxides.

When included therein, the cleaning compositions of the present invention typically comprise from about 0.2%, preferably from about 1% to about 15%, preferably to about 10% by weight of such semi-polar nonionic surfactants.

Cosurfactants - The cleaning compositions of the present invention may further comprise a cosurfactant selected from the group of primary or tertiary amines. Suitable primary amines for use herein include amines according to the formula R_1NH_2 wherein R_1 is a C_6 - C_{12} , preferably C_6 - C_{10} alkyl chain or $R_4X(CH_2)_n$, X is -O-, -C(O)NH- or -NH-, R_4 is a C_6 - C_{12} alkyl chain n is between 1 to 5, preferably 3. R_1 alkyl chains may be straight or branched and may be interrupted with up to 12, preferably less than 5 ethylene oxide moieties.

Preferred amines according to the formula herein above are n-alkyl amines. Suitable amines for use herein may be selected from 1-hexylamine, 1-octylamine, 1-decylamine and laurylamine. Other preferred primary amines include C8-C10 oxypropylamine, octyloxypropylamine, 2-ethylhexyl-oxypropylamine, lauryl amido propylamine and amido propylamine. The most preferred amines for use in the compositions herein are 1-hexylamine, 1-octylamine, 1-decylamine, 1-dodecylamine. Especially desirable are n-dodecyldimethylamine and bishydroxyethylcoconutalkylamine and oleylamine 7 times ethoxylated, lauryl amido propylamine and cocoamido propylamine.

LFNIs - Particularly preferred surfactants in the automatic dishwashing compositions (ADD) of the present invention are low foaming nonionic surfactants (LFNI) which are described in U.S. Patent Nos. 5,705,464 and 5,710,115. LFNI may be present in amounts from 0.01% to about 10% by weight, preferably from about 0.1% to about 10%, and most preferably from about 0.25% to about 4%. LFNIs are most typically used in ADDs on account of the improved water-sheeting action (especially from glass) which they confer to the ADD product. They also encompass non-silicone, nonphosphate polymeric materials further illustrated hereinafter which are known to defoam food soils encountered in automatic dishwashing.

Preferred LFNIs include nonionic alkoxyated surfactants, especially ethoxylates derived from primary alcohols, and blends thereof with more sophisticated surfactants, such as the polyoxypropylene/polyoxyethylene/polyoxypropylene (PO/EO/PO) reverse block polymers as described in U.S. Patent Nos. 5,705,464 and 5,710,115.

LFNIs which may also be used include those POLY-TERGENT® SLF-18 nonionic surfactants from Olin Corp., and any biodegradable LFNI having the melting point properties discussed hereinabove.

These and other nonionic surfactants are well known in the art, being described in more detail in Kirk Othmer's Encyclopedia of Chemical Technology, 3rd Ed., Vol. 22, pp. 360-379, "Surfactants and Detergent Systems", incorporated by reference herein.

Bleaching System - The cleaning compositions of the present invention preferably comprise a bleaching system. Bleaching systems typically comprise a "bleaching agent" (source of hydrogen peroxide) and an "initiator" or "catalyst". When present, bleaching agents will typically be at levels of from about 1%, preferably from about 5% to about 30%, preferably to about 20% by weight of the composition. If present, the amount of bleach activator will typically be from about 0.1%, preferably from about 0.5% to about 60%, preferably to about 40% by weight, of the bleaching composition comprising the bleaching agent-plus-bleach activator.

Bleaching Agents - Hydrogen peroxide sources are described in detail in the herein incorporated Kirk Othmer's Encyclopedia of Chemical Technology, 4th Ed (1992, John Wiley & Sons), Vol. 4, pp. 271-300 "Bleaching Agents (Survey)", and include the various forms of sodium perborate and sodium percarbonate, including various coated and modified forms.

The preferred source of hydrogen peroxide used herein can be any convenient source, including hydrogen peroxide itself. For example, perborate, e.g., sodium perborate (any hydrate but preferably the mono- or tetra-hydrate), sodium carbonate peroxyhydrate or equivalent percarbonate salts, sodium pyrophosphate peroxyhydrate, urea peroxyhydrate, or sodium peroxide can be used herein. Also useful are sources of available oxygen such as persulfate bleach (e.g., OXONE, manufactured by DuPont). Sodium perborate monohydrate and sodium percarbonate are particularly preferred. Mixtures of any convenient hydrogen peroxide sources can also be used.

A preferred percarbonate bleach comprises dry particles having an average particle size in the range from about 500 micrometers to about 1,000 micrometers, not more than about 10% by weight of said particles being smaller than about 200 micrometers and not more than about 10% by weight of said particles being larger than about 1,250 micrometers. Optionally, the percarbonate can be coated with a silicate, borate or water-soluble surfactants. Percarbonate is available from various commercial sources such as FMC, Solvay and Tokai Denka.

Compositions of the present invention may also comprise as the bleaching agent a chlorine-type bleaching material. Such agents are well known in the art, and include for example sodium dichloroisocyanurate ("NaDCC"). However, chlorine-type bleaches are less preferred for compositions which comprise enzymes.

(a) Bleach Activators - Preferably, the peroxygen bleach component in the composition is formulated with an activator (peracid precursor). The activator is present at

levels of from about 0.01%, preferably from about 0.5%, more preferably from about 1% to about 15%, preferably to about 10%, more preferably to about 8%, by weight of the composition. Preferred activators are selected from the group consisting of tetraacetyl ethylene diamine (TAED), benzoylcaprolactam (BzCL), 4-nitrobenzoylcaprolactam, 3-chlorobenzoylcaprolactam, benzoyloxybenzenesulphonate (BOBS), nonanoyloxybenzenesulphonate (NOBS), phenyl benzoate (PhBz), decanoyloxybenzenesulphonate (C₁₀-OBS), benzoylvalerolactam (BZVL), octanoyloxybenzenesulphonate (C₈-OBS), perhydrolyzable esters and mixtures thereof, most preferably benzoylcaprolactam and benzoylvalerolactam. Particularly preferred bleach activators in the pH range from about 8 to about 9.5 are those selected having an OBS or VL leaving group.

Preferred hydrophobic bleach activators include, but are not limited to, nonanoyloxybenzenesulphonate (NOBS), 4-[N-(nonaoyl) amino hexanoyloxy]-benzene sulfonate sodium salt (NACA-OBS) an example of which is described in U.S. Patent No. 5,523,434, dodecanoyloxybenzenesulphonate (LOBS or C₁₂-OBS), 10-undecenoyloxybenzenesulfonate (UDOBS or C₁₁-OBS with unsaturation in the 10 position), and decanoyloxybenzoic acid (DOBA).

Preferred bleach activators are those described in U.S. 5,698,504 Christie et al., issued December 16, 1997; U.S. 5,695,679 Christie et al. issued December 9, 1997; U.S. 5,686,401 Willey et al., issued November 11, 1997; U.S. 5,686,014 Hartshorn et al., issued November 11, 1997; U.S. 5,405,412 Willey et al., issued April 11, 1995; U.S. 5,405,413 Willey et al., issued April 11, 1995; U.S. 5,130,045 Mitchel et al., issued July 14, 1992; and U.S. 4,412,934 Chung et al., issued November 1, 1983, and copending patent applications U. S. Serial Nos. 08/709,072, 08/064,564, all of which are incorporated herein by reference.

The mole ratio of peroxygen bleaching compound (as AvO) to bleach activator in the present invention generally ranges from at least 1:1, preferably from about 20:1, more preferably from about 10:1 to about 1:1, preferably to about 3:1.

Quaternary substituted bleach activators may also be included. The present cleaning compositions preferably comprise a quaternary substituted bleach activator (QSBA) or a quaternary substituted peracid (QSP); more preferably, the former. Preferred QSBA structures are further described in U.S. 5,686,015 Willey et al., issued November 11, 1997; U.S. 5,654,421 Taylor et al., issued August 5, 1997; U.S. 5,460,747 Gosselink et al., issued October 24, 1995; U.S. 5,584,888 Miracle et al., issued December 17, 1996; and U.S. 5,578,136 Taylor et al., issued November 26, 1996; all of which are incorporated herein by reference.

Highly preferred bleach activators useful herein are amide-substituted as described in U.S. 5,698,504, U.S. 5,695,679, and U.S. 5,686,014 each of which are cited herein above. Preferred examples of such bleach activators include: (6-octanamidocaproyl)

oxybenzenesulfonate, (6-nonanamidocaproyl)oxybenzenesulfonate, (6-decanamidocaproyl)oxybenzenesulfonate and mixtures thereof.

Other useful activators, disclosed in U.S. 5,698,504, U.S. 5,695,679, U.S. 5,686,014 each of which is cited herein above and U.S. 4,966,723 Hodge et al., issued October 30, 1990, include benzoxazin-type activators, such as a C_6H_4 ring to which is fused in the 1,2-positions a moiety $-C(O)OC(R^1)=N-$.

Depending on the activator and precise application, good bleaching results can be obtained from bleaching systems having with in-use pH of from about 6 to about 13, preferably from about 9.0 to about 10.5. Typically, for example, activators with electron-withdrawing moieties are used for near-neutral or sub-neutral pH ranges. Alkalis and buffering agents can be used to secure such pH.

Acyl lactam activators, as described in U.S. 5,698,504, U.S. 5,695,679 and U.S. 5,686,014, each of which is cited herein above, are very useful herein, especially the acyl caprolactams (see for example WO 94-28102 A) and acyl valerolactams (see U.S. 5,503,639 Willey et al., issued April 2, 1996 incorporated herein by reference).

(b) Organic Peroxides, especially Diacyl Peroxides - These are extensively illustrated in Kirk Othmer, Encyclopedia of Chemical Technology, Vol. 17, John Wiley and Sons, 1982 at pages 27-90 and especially at pages 63-72, all incorporated herein by reference. If a diacyl peroxide is used, it will preferably be one which exerts minimal adverse impact on spotting/filming.

(c) Metal-containing Bleach Catalysts - The present invention compositions and methods may utilize metal-containing bleach catalysts that are effective for use in bleaching compositions. Preferred are manganese and cobalt-containing bleach catalysts.

One type of metal-containing bleach catalyst is a catalyst system comprising a transition metal cation of defined bleach catalytic activity, such as copper, iron, titanium, ruthenium tungsten, molybdenum, or manganese cations, an auxiliary metal cation having little or no bleach catalytic activity, such as zinc or aluminum cations, and a sequester having defined stability constants for the catalytic and auxiliary metal cations, particularly ethylenediaminetetraacetic acid, ethylenediaminetetra (methylenephosphonic acid) and water-soluble salts thereof. Such catalysts are disclosed in U.S. 4,430,243 Bragg, issued February 2, 1982.

Manganese Metal Complexes - If desired, the compositions herein can be catalyzed by means of a manganese compound. Such compounds and levels of use are well known in the art and include, for example, the manganese-based catalysts disclosed in U.S. Patent Nos. 5,576,282; 5,246,621; 5,244,594; 5,194,416; and 5,114,606; and European Pat. App. Pub. Nos. 549,271 A1, 549,272 A1, 544,440 A2, and 544,490 A1; Preferred examples of these catalysts include $Mn^{IV}_2(u-O)_3(1,4,7\text{-trimethyl-1,4,7-triazacyclononane})_2(PF_6)_2$,

$\text{Mn}^{\text{III}}_2(\text{u-O})_1(\text{u-OAc})_2(1,4,7\text{-trimethyl-}1,4,7\text{-triazacyclononane})_2(\text{ClO}_4)_2$, $\text{Mn}^{\text{IV}}_4(\text{u-O})_6(1,4,7\text{-triazacyclononane})_4(\text{ClO}_4)_4$, $\text{Mn}^{\text{III}}\text{Mn}^{\text{IV}}_4(\text{u-O})_1(\text{u-OAc})_2(1,4,7\text{-trimethyl-}1,4,7\text{-triazacyclononane})_2(\text{ClO}_4)_3$, $\text{Mn}^{\text{IV}}(1,4,7\text{-trimethyl-}1,4,7\text{-triazacyclononane})\text{-(OCH}_3)_3(\text{PF}_6)$, and mixtures thereof. Other metal-based bleach catalysts include those disclosed in U.S. Patent Nos. 4,430,243 and U.S. 5,114,611. The use of manganese with various complex ligands to enhance bleaching is also reported in the following: U.S. Patent Nos. 4,728,455; 5,284,944; 5,246,612; 5,256,779; 5,280,117; 5,274,147; 5,153,161; and 5,227,084.

Cobalt Metal Complexes - Cobalt bleach catalysts useful herein are known, and are described, for example, in U.S. Patent Nos. 5,597,936; 5,595,967; and 5,703,030; and M. L. Tobe, "Base Hydrolysis of Transition-Metal Complexes", Adv. Inorg. Bioinorg. Mech., (1983), 2, pages 1-94. The most preferred cobalt catalyst useful herein are cobalt pentaamine acetate salts having the formula $[\text{Co}(\text{NH}_3)_5\text{OAc}] \text{ T}_y$, wherein "OAc" represents an acetate moiety and "T_y" is an anion, and especially cobalt pentaamine acetate chloride, $[\text{Co}(\text{NH}_3)_5\text{OAc}]\text{Cl}_2$; as well as $[\text{Co}(\text{NH}_3)_5\text{OAc}](\text{OAc})_2$; $[\text{Co}(\text{NH}_3)_5\text{OAc}](\text{PF}_6)_2$; $[\text{Co}(\text{NH}_3)_5\text{OAc}](\text{SO}_4)$; $[\text{Co}(\text{NH}_3)_5\text{OAc}](\text{BF}_4)_2$; and $[\text{Co}(\text{NH}_3)_5\text{OAc}](\text{NO}_3)_2$ (herein "PAC").

These cobalt catalysts are readily prepared by known procedures, such as taught for example in U.S. Patent Nos. 5,597,936; 5,595,967; and 5,703,030; in the Tobe article and the references cited therein; and in U.S. Patent 4,810,410; J. Chem. Ed. (1989), 66 (12), 1043-45; The Synthesis and Characterization of Inorganic Compounds, W.L. Jolly (Prentice-Hall; 1970), pp. 461-3; Inorg. Chem., 18, 1497-1502 (1979); Inorg. Chem., 21, 2881-2885 (1982); Inorg. Chem., 18, 2023-2025 (1979); Inorg. Synthesis, 173-176 (1960); and Journal of Physical Chemistry, 56, 22-25 (1952).

Transition Metal Complexes of Macropolycyclic Rigid Ligands - Compositions herein may also suitably include as bleach catalyst a transition metal complex of a macropolycyclic rigid ligand. The phrase "macropolycyclic rigid ligand" is sometimes abbreviated as "MRL" in discussion below. The amount used is a catalytically effective amount, suitably about 1 ppb or more, for example up to about 99.9%, more typically about 0.001 ppm or more, preferably from about 0.05 ppm to about 500 ppm (wherein "ppb" denotes parts per billion by weight and "ppm" denotes parts per million by weight).

Suitable transition metals e.g., Mn are illustrated hereinafter. "Macropolycyclic" means a MRL is both a macrocycle and is polycyclic. "Polycyclic" means at least bicyclic. The term "rigid" as used herein includes "having a superstructure" and "cross-bridged". "Rigid" has been defined as the constrained converse of flexibility: see D.H. Busch., Chemical Reviews. (1993), 93, 847-860, incorporated by reference. More particularly, "rigid" as used herein means that the MRL must be determinably more rigid

than a macrocycle ("parent macrocycle") which is otherwise identical (having the same ring size and type and number of atoms in the main ring) but lacking a superstructure (especially linking moieties or, preferably cross-bridging moieties) found in the MRL's. In determining the comparative rigidity of macrocycles with and without superstructures, the practitioner will use the free form (not the metal-bound form) of the macrocycles. Rigidity is well-known to be useful in comparing macrocycles; suitable tools for determining, measuring or comparing rigidity include computational methods (see, for example, Zimmer, *Chemical Reviews*, (1995), 95(38), 2629-2648 or Hancock et al., *Inorganica Chimica Acta*, (1989), 164, 73-84.

Preferred MRL's herein are a special type of ultra-rigid ligand which is cross-bridged. A "cross-bridge" is nonlimitingly illustrated in 1.11 hereinbelow. In 1.11, the cross-bridge is a $-\text{CH}_2\text{CH}_2-$ moiety. It bridges N^1 and N^8 in the illustrative structure. By comparison, a "same-side" bridge, for example if one were to be introduced across N^1 and N^{12} in 1.11, would not be sufficient to constitute a "cross-bridge" and accordingly would not be preferred.

Suitable metals in the rigid ligand complexes include Mn(II), Mn(III), Mn(IV), Mn(V), Fe(II), Fe(III), Fe(IV), Co(I), Co(II), Co(III), Ni(I), Ni(II), Ni(III), Cu(I), Cu(II), Cu(III), Cr(II), Cr(III), Cr(IV), Cr(V), Cr(VI), V(III), V(IV), V(V), Mo(IV), Mo(V), Mo(VI), W(IV), W(V), W(VI), Pd(II), Ru(II), Ru(III), and Ru(IV). Preferred transition-metals in the instant transition-metal bleach catalyst include manganese, iron and chromium.

More generally, the MRL's (and the corresponding transition-metal catalysts) herein suitably comprise:

- (a) at least one macrocycle main ring comprising four or more heteroatoms; and
- (b) a covalently connected non-metal superstructure capable of increasing the rigidity of the macrocycle, preferably selected from
 - (i) a bridging superstructure, such as a linking moiety;
 - (ii) a cross-bridging superstructure, such as a cross-bridging linking moiety; and
 - (iii) combinations thereof.

The term "superstructure" is used herein as defined in the literature by Busch et al., see, for example, articles by Busch in "Chemical Reviews".

Preferred superstructures herein not only enhance the rigidity of the parent macrocycle, but also favor folding of the macrocycle so that it co-ordinates to a metal in a cleft. Suitable superstructures can be remarkably simple, for example a linking moiety such as any of those illustrated in Fig. 1 and Fig. 2 below, can be used.

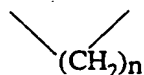


Fig. 1

wherein n is an integer, for example from 2 to 8, preferably less than 6, typically 2 to 4, or

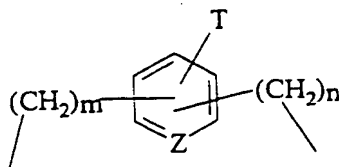


Fig. 2

wherein m and n are integers from about 1 to 8, more preferably from 1 to 3; Z is N or CH; and T is a compatible substituent, for example H, alkyl, trialkylammonium, halogen, nitro, sulfonate, or the like. The aromatic ring in 1.10 can be replaced by a saturated ring, in which the atom in Z connecting into the ring can contain N, O, S or C.

Suitable MRL's are further nonlimitingly illustrated by the following compound:

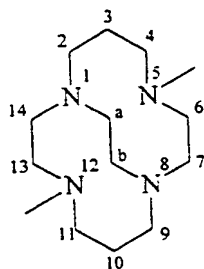


Fig. 3

This is a MRL in accordance with the invention which is a highly preferred, cross-bridged, methyl-substituted (all nitrogen atoms tertiary) derivative of cyclam. Formally, this ligand is named 5,12-dimethyl-1,5,8,12-tetraazabicyclo[6.6.2]hexadecane using the extended von Baeyer system. See "A Guide to IUPAC Nomenclature of Organic Compounds: Recommendations 1993", R. Panico, W.H. Powell and J-C Richer (Eds.), Blackwell Scientific Publications, Boston, 1993; see especially section R-2.4.2.1.

Transition-metal bleach catalysts of Macrocyclic Rigid Ligands which are suitable for use in the invention compositions can in general include known compounds where they conform with the definition herein, as well as, more preferably, any of a large number of novel compounds expressly designed for the present laundry or cleaning uses, and non-limitingly illustrated by any of the following:

Dichloro-5,12-dimethyl-1,5,8,12-tetraazabicyclo[6.6.2]hexadecane Manganese(II)

Diaquo-5,12-dimethyl-1,5,8,12-tetraazabicyclo[6.6.2]hexadecane Manganese(II)

Hexafluorophosphate

Aquo-hydroxy-5,12-dimethyl-1,5,8,12-tetraazabicyclo[6.6.2]hexadecane Manganese(III)

Hexafluorophosphate

Diaquo-5,12-dimethyl-1,5,8,12-tetraazabicyclo[6.6.2]hexadecane Manganese(II)

Tetrafluoroborate

Dichloro-5,12-dimethyl-1,5,8,12-tetraazabicyclo[6.6.2]hexadecane Manganese(III)

Hexafluorophosphate

Dichloro-5,12-di-n-butyl-1,5,8,12-tetraaza bicyclo[6.6.2]hexadecane Manganese(II)

Dichloro-5,12-dibenzyl-1,5,8,12-tetraazabicyclo[6.6.2]hexadecane Manganese(II)

Dichloro-5-n-butyl-12-methyl-1,5,8,12-tetraaza- bicyclo[6.6.2]hexadecane Manganese(II)

Dichloro-5-n-octyl-12-methyl-1,5,8,12-tetraaza- bicyclo[6.6.2]hexadecane Manganese(II)

Dichloro-5-n-butyl-12-methyl-1,5,8,12-tetraaza- bicyclo[6.6.2]hexadecane Manganese(II).

As a practical matter, and not by way of limitation, the compositions and cleaning processes herein can be adjusted to provide on the order of at least one part per hundred million of the active bleach catalyst species in the aqueous washing medium, and will preferably provide from about 0.01 ppm to about 25 ppm, more preferably from about 0.05 ppm to about 10 ppm, and most preferably from about 0.1 ppm to about 5 ppm, of the bleach catalyst species in the wash liquor. In order to obtain such levels in the wash liquor of an automatic washing process, typical compositions herein will comprise from about 0.0005% to about 0.2%, more preferably from about 0.004% to about 0.08%, of bleach catalyst, especially manganese or cobalt catalysts, by weight of the bleaching compositions.

(d) Other Bleach Catalysts - The compositions herein may comprise one or more other bleach catalysts. Preferred bleach catalysts are zwitterionic bleach catalysts, which are described in U.S. Patent No. 5,576,282 (especially 3-(3,4-dihydroisoquinolinium) propane sulfonate. Other bleach catalysts include cationic bleach catalysts are described in U.S. Patent Nos. 5,360,569, 5,442,066, 5,478,357, 5,370,826, 5,482,515, 5,550,256, and WO 95/13351, WO 95/13352, and WO 95/13353.

Also suitable as bleaching agents are preformed peracids, such as phthalimido-peroxy-caproic acid ("PAP"). See for example U.S. Patent Nos. 5,487,818, 5,310,934, 5,246,620, 5,279,757 and 5,132,431.

Optional Detergent Enzymes - The detergent and cleaning compositions herein may also optionally contain one or more types of detergent enzymes. Such enzymes can include other proteases, amylases, cellulases and lipases. Such materials are known in the art and are commercially available under such trademarks as . They may be incorporated into the non-aqueous liquid detergent compositions herein in the form of suspensions, "marumes" or "prills". Another suitable type of enzyme comprises those in the form of slurries of enzymes in nonionic surfactants, e.g., the enzymes marketed by Novo Nordisk under the tradename "SL" or the microencapsulated enzymes marketed by Novo Nordisk under the tradename "LDP." Suitable enzymes and levels of use are described in U.S. Pat. No. 5,576,282, 5,705,464 and 5,710,115.

Enzymes added to the compositions herein in the form of conventional enzyme prills are especially preferred for use herein. Such prills will generally range in size from about 100 to 1,000 microns, more preferably from about 200 to 800 microns and will be suspended throughout the non-aqueous liquid phase of the composition. Prills in the compositions of the present invention have been found, in comparison with other enzyme forms, to exhibit especially desirable enzyme stability in terms of retention of enzymatic activity over time. Thus, compositions which utilize enzyme prills need not contain conventional enzyme stabilizing such as must frequently be used when enzymes are incorporated into aqueous liquid detergents.

However, enzymes added to the compositions herein may be in the form of granulates, preferably T-granulates.

"Detergent enzyme", as used herein, means any enzyme having a cleaning, stain removing or otherwise beneficial effect in a laundry, hard surface cleaning or personal care detergent composition. Preferred detergent enzymes are hydrolases such as proteases, amylases and lipases. Preferred enzymes for laundry purposes include, but are not limited to, proteases, cellulases, lipases and peroxidases. Highly preferred for automatic dishwashing are amylases and/or proteases, including both current commercially available types and improved types which, though more and more bleach compatible though successive improvements, have a remaining degree of bleach deactivation susceptibility.

Examples of suitable enzymes include, but are not limited to, hemicellulases, peroxidases, proteases, cellulases, xylanases, lipases, phospholipases, esterases, cutinases, pectinases, keratanases, reductases, oxidases, phenoloxidases, lipoxigenases, ligninases, pullulanases, tannases, pentosanases, malanases, β -glucanases, arabinosidases, hyaluronidase, chondroitinase, laccase, and known amylases, or mixtures thereof.

Examples of such suitable enzymes are disclosed in U.S. Patent Nos. 5,705,464, 5,710,115, 5,576,282, 5,728,671 and 5,707,950

The cellulases useful in the present invention include both bacterial or fungal cellulases. Preferably, they will have a pH optimum of between 5 and 12 and a specific activity above 50 CEVU/mg (Cellulose Viscosity Unit). Suitable cellulases are disclosed in U.S. Patent 4,435,307, J61078384 and WO96/02653 which discloses fungal cellulase produced respectively from *Humicola insolens*, *Trichoderma*, *Thielavia* and *Sporotrichum*. EP 739 982 describes cellulases isolated from novel *Bacillus* species. Suitable cellulases are also disclosed in GB-A-2.075.028; GB-A-2.095.275; DE-OS-2.247.832 and WO95/26398.

Examples of such cellulases are cellulases produced by a strain of *Humicola insolens* (*Humicola grisea* var. *thermoidea*), particularly the *Humicola* strain DSM 1800.

Other suitable cellulases are cellulases originated from *Humicola insolens* having a molecular weight of about 50KDa, an isoelectric point of 5.5 and containing 415 amino acids; and a ~43kD endoglucanase derived from *Humicola insolens*, DSM 1800, exhibiting cellulase activity; a preferred endoglucanase component has the amino acid sequence disclosed in WO 91/17243. Also suitable cellulases are the EGIII cellulases from *Trichoderma longibrachiatum* described in WO94/21801 to Genencor. Especially suitable cellulases are the cellulases having color care benefits. Examples of such cellulases are cellulases described in European patent application No. 91202879.2, filed November 6, 1991 (Novo). Carezyme and Celluzyme (Novo Nordisk A/S) are especially useful. See also WO91/17244 and WO91/21801. Other suitable cellulases for fabric care and/or cleaning properties are described in WO96/34092, WO96/17994 and WO95/24471.

Cellulases, when present, are normally incorporated in the cleaning composition at levels from 0.0001% to 2% of pure enzyme by weight of the cleaning composition.

Peroxidase enzymes are used in combination with oxygen sources, e.g. percarbonate, perborate, persulfate, hydrogen peroxide, etc and with a phenolic substrate as bleach enhancing molecule. They are used for "solution bleaching", i.e. to prevent transfer of dyes or pigments removed from substrates during wash operations to other substrates in the wash solution. Peroxidase enzymes are known in the art, and include, for example, horseradish peroxidase, ligninase and haloperoxidase such as chloro- and bromoperoxidase. Suitable peroxidases and peroxidase-containing detergent compositions are disclosed, for example, in U.S. Patent Nos. 5,705,464, 5,710,115, 5,576,282, 5,728,671 and 5,707,950, PCT International Application WO 89/099813, WO89/09813 and in European Patent application EP No. 91202882.6, filed on November 6, 1991 and EP No. 96870013.8, filed February 20, 1996. Also suitable is the laccase enzyme.

Enhancers are generally comprised at a level of from 0.1% to 5% by weight of total composition. Preferred enhancers are substituted phenothiazine and phenoxazine 10-Phenothiazinepropionic acid (PPT), 10-ethylphenothiazine-4-carboxylic acid (EPC), 10-phenoxazinepropionic acid (POP) and 10-methylphenoxazine (described in WO 94/12621) and substituted syringates (C3-C5 substituted alkyl syringates) and phenols. Sodium percarbonate or perborate are preferred sources of hydrogen peroxide. Said peroxidases are normally incorporated in the cleaning composition at levels from 0.0001% to 2% of pure enzyme by weight of the cleaning composition.

Enzymatic systems may be used as bleaching agents. The hydrogen peroxide may also be present by adding an enzymatic system (i.e. an enzyme and a substrate therefore) which is capable of generating hydrogen peroxide at the beginning or during the washing and/or rinsing process. Such enzymatic systems are disclosed in EP Patent Application 91202655.6 filed October 9, 1991.

Other preferred enzymes that can be included in the cleaning compositions of the present invention include lipases. Suitable lipase enzymes for detergent usage include those produced by microorganisms of the *Pseudomonas* group, such as *Pseudomonas stutzeri* ATCC 19.154, as disclosed in British Patent 1,372,034. Suitable lipases include those which show a positive immunological cross-reaction with the antibody of the lipase, produced by the microorganism *Pseudomonas fluorescent* IAM 1057. This lipase is available from Amano Pharmaceutical Co. Ltd., Nagoya, Japan, under the trade name Lipase P "Amano," hereinafter referred to as "Amano-P". Other suitable commercial lipases include Amano-CES, lipases ex *Chromobacter viscosum*, e.g. *Chromobacter viscosum* var. *lipolyticum* NRRLB 3673 from Toyo Jozo Co., Tagata, Japan; *Chromobacter viscosum* lipases from U.S. Biochemical Corp., U.S.A. and Disoynt Co., The Netherlands, and lipases ex *Pseudomonas gladioli*. Especially suitable lipases are lipases such as M1 Lipase^R and Lipomax^R (Gist-Brocades) and Lipolase^R and Lipolase Ultra^R(Novo) which have found to be very effective when used in combination with the compositions of the present invention. Also suitable are the lipolytic enzymes described in EP 258 068, WO 92/05249 and WO 95/22615 by Novo Nordisk and in WO 94/03578, WO 95/35381 and WO 96/00292 by Unilever.

Also suitable are cutinases [EC 3.1.1.50] which can be considered as a special kind of lipase, namely lipases which do not require interfacial activation. Addition of cutinases to cleaning compositions have been described in e.g. WO-A-88/09367 (Genencor); WO 90/09446 (Plant Genetic System) and WO 94/14963 and WO 94/14964 (Unilever).

Lipases and/or cutinases, when present, are normally incorporated in the cleaning composition at levels from 0.0001% to 2% of pure enzyme by weight of the cleaning composition.

In addition to the above referenced lipases, phospholipases may be incorporated into the cleaning compositions of the present invention. Nonlimiting examples of suitable phospholipases included: EC 3.1.1.32 Phospholipase A1; EC 3.1.1.4 Phospholipase A2; EC 3.1.1.5 Lysopholipase; EC 3.1.4.3 Phospholipase C; EC 3.1.4.4. Phospholipase D. Commercially available phospholipases include LECITASE[®] from Novo Nordisk A/S of Denmark and Phospholipase A2 from Sigma. When phospholipases are included in the compositions of the present invention, it is preferred that amylases are also included. Without desiring to be bound by theory, it is believed that the combined action of the phospholipase and amylase provide substantive stain removal, especially on greasy/oily, starchy and highly colored stains and soils. Preferably, the phospholipase and amylase, when present, are incorporated into the compositions of the present invention at a pure enzyme weight ratio between 4500:1 and 1:5, more preferably between 50:1 and 1:1.

Suitable proteases are the subtilisins which are obtained from particular strains of *B. subtilis* and *B. licheniformis* (subtilisin BPN and BPN'). One suitable protease is obtained from a strain of *Bacillus*, having maximum activity throughout the pH range of 8-12, developed and sold as ESPERASE® by Novo Industries A/S of Denmark, hereinafter "Novo". The preparation of this enzyme and analogous enzymes is described in GB 1,243,784 to Novo. Proteolytic enzymes also encompass modified bacterial serine proteases, such as those described in European Patent Application Serial Number 87 303761.8, filed April 28, 1987 (particularly pages 17, 24 and 98), and which is called herein "Protease B", and in European Patent Application 199,404, Venegas, published October 29, 1986, which refers to a modified bacterial serine proteolytic enzyme which is called "Protease A" herein. Suitable is the protease called herein "Protease C", which is a variant of an alkaline serine protease from *Bacillus* in which Lysine replaced arginine at position 27, tyrosine replaced valine at position 104, serine replaced asparagine at position 123, and alanine replaced threonine at position 274. Protease C is described in EP 90915958:4, corresponding to WO 91/06637, Published May 16, 1991. Genetically modified variants, particularly of Protease C, are also included herein.

A preferred protease referred to as "Protease D" is a carbonyl hydrolase as described in U.S. Patent No. 5,677,272, and WO95/10591. Also suitable is a carbonyl hydrolase variant of the protease described in WO95/10591, having an amino acid sequence derived by replacement of a plurality of amino acid residues replaced in the precursor enzyme corresponding to position +210 in combination with one or more of the following residues : +33, +62, +67, +76, +100, +101, +103, +104, +107, +128, +129, +130, +132, +135, +156, +158, +164, +166, +167, +170, +209, +215, +217, +218, and +222, where the numbered position corresponds to naturally-occurring subtilisin from *Bacillus amyloliquefaciens* or to equivalent amino acid residues in other carbonyl hydrolases or subtilisins, such as *Bacillus lentus* subtilisin (co-pending patent application US Serial No. 60/048,550, filed June 04, 1997 and PCT International Application Serial No. PCT/IB98/00853).

Also suitable for the present invention are proteases described in patent applications EP 251 446 and WO 91/06637, protease BLAP® described in WO91/02792 and their variants described in WO 95/23221.

See also a high pH protease from *Bacillus* sp. NCIMB 40338 described in WO 93/18140 A to Novo. Enzymatic detergents comprising protease, one or more other enzymes, and a reversible protease inhibitor are described in WO 92/03529 A to Novo. When desired, a protease having decreased adsorption and increased hydrolysis is available as described in WO 95/07791 to Procter & Gamble. A recombinant trypsin-like protease

Other preferred enzymes that can be included in the cleaning compositions of the present invention include lipases. Suitable lipase enzymes for detergent usage include those produced by microorganisms of the *Pseudomonas* group, such as *Pseudomonas stutzeri* ATCC 19.154, as disclosed in British Patent 1,372,034. Suitable lipases include those which show a positive immunological cross-reaction with the antibody of the lipase, produced by the microorganism *Pseudomonas fluorescent* IAM 1057. This lipase is available from Amano Pharmaceutical Co. Ltd., Nagoya, Japan, under the trade name Lipase P "Amano," hereinafter referred to as "Amano-P". Other suitable commercial lipases include Amano-CES, lipases ex *Chromobacter viscosum*, e.g. *Chromobacter viscosum* var. *lipolyticum* NRRLB 3673 from Toyo Jozo Co., Tagata, Japan; *Chromobacter viscosum* lipases from U.S. Biochemical Corp., U.S.A. and Disoynt Co., The Netherlands, and lipases ex *Pseudomonas gladioli*. Especially suitable lipases are lipases such as M1 Lipase^R and Lipomax^R (Gist-Brocades) and Lipolase^R and Lipolase Ultra^R (Novo) which have found to be very effective when used in combination with the compositions of the present invention. Also suitable are the lipolytic enzymes described in EP 258 068, WO 92/05249 and WO 95/22615 by Novo Nordisk and in WO 94/03578, WO 95/35381 and WO 96/00292 by Unilever.

Also suitable are cutinases [EC 3.1.1.50] which can be considered as a special kind of lipase, namely lipases which do not require interfacial activation. Addition of cutinases to cleaning compositions have been described in e.g. WO-A-88/09367 (Genencor); WO 90/09446 (Plant Genetic System) and WO 94/14963 and WO 94/14964 (Unilever).

Lipases and/or cutinases, when present, are normally incorporated in the cleaning composition at levels from 0.0001% to 2% of pure enzyme by weight of the cleaning composition.

In addition to the above referenced lipases, phospholipases may be incorporated into the cleaning compositions of the present invention. Nonlimiting examples of suitable phospholipases included: EC 3.1.1.32 Phospholipase A1; EC 3.1.1.4 Phospholipase A2; EC 3.1.1.5 Lysopholipase; EC 3.1.4.3 Phospholipase C; EC 3.1.4.4. Phospholipase D. Commercially available phospholipases include LECITASE[®] from Novo Nordisk A/S of Denmark and Phospholipase A2 from Sigma. When phospholipases are included in the compositions of the present invention, it is preferred that amylases are also included. Without desiring to be bound by theory, it is believed that the combined action of the phospholipase and amylase provide substantive stain removal, especially on greasy/oily, starchy and highly colored stains and soils. Preferably, the phospholipase and amylase, when present, are incorporated into the compositions of the present invention at a pure enzyme weight ratio between 4500:1 and 1:5, more preferably between 50:1 and 1:1.

(psychrophilic, psychrotrophic, thermophilic, barophilic, alkalophilic, acidophilic, halophilic, etc.). Purified or non-purified forms of these enzymes may be used. Nowadays, it is common practice to modify wild-type enzymes via protein / genetic engineering techniques in order to optimize their performance efficiency in the laundry detergent and/or fabric care compositions of the invention. For example, the variants may be designed such that the compatibility of the enzyme to commonly encountered ingredients of such compositions is increased. Alternatively, the variant may be designed such that the optimal pH, bleach or chelant stability, catalytic activity and the like, of the enzyme variant is tailored to suit the particular cleaning application.

In particular, attention should be focused on amino acids sensitive to oxidation in the case of bleach stability and on surface charges for the surfactant compatibility. The isoelectric point of such enzymes may be modified by the substitution of some charged amino acids, e.g. an increase in isoelectric point may help to improve compatibility with anionic surfactants. The stability of the enzymes may be further enhanced by the creation of e.g. additional salt bridges and enforcing calcium binding sites to increase chelant stability.

These optional detergent enzymes, when present, are normally incorporated in the cleaning composition at levels from 0.0001% to 2% of pure enzyme by weight of the cleaning composition. The enzymes can be added as separate single ingredients (prills, granulates, stabilized liquids, etc... containing one enzyme) or as mixtures of two or more enzymes (e.g. cogramulates).

Other suitable detergent ingredients that can be added are enzyme oxidation scavengers. Examples of such enzyme oxidation scavengers are ethoxylated tetraethylene polyamines.

A range of enzyme materials and means for their incorporation into synthetic detergent compositions is also disclosed in WO 9307263 and WO 9307260 to Genencor International, WO 8908694, and U.S. 3,553,139, January 5, 1971 to McCarty et al. Enzymes are further disclosed in U.S. 4,101,457, and in U.S. 4,507,219. Enzyme materials useful for liquid detergent formulations, and their incorporation into such formulations, are disclosed in U.S. 4,261,868.

Enzyme Stabilizers - Enzymes for use in detergents can be stabilized by various techniques. Enzyme stabilization techniques are disclosed and exemplified in U.S. 3,600,319, EP 199,405 and EP 200,586. Enzyme stabilization systems are also described, for example, in U.S. 3,519,570. A useful *Bacillus*, sp. AC13 giving proteases, xylanases and cellulases, is described in WO 9401532. The enzymes employed herein can be stabilized by the presence of water-soluble sources of calcium and/or magnesium ions in the finished compositions which provide such ions to the enzymes. Suitable enzyme stabilizers and levels of use are described in U.S. Pat. Nos. 5,705,464, 5,710,115 and 5,576,282.

for detergents suitable herein is described in WO 94/25583 to Novo. Other suitable proteases are described in EP 516 200 by Unilever.

Particularly useful proteases are described in PCT publications: WO 95/30010; WO 95/30011; and WO 95/29979. Suitable proteases are commercially available as ESPERASE[®], ALCALASE[®], DURAZYM[®], SAVINASE[®], EVERLASE[®] and KANNASE[®] all from Novo Nordisk A/S of Denmark, and as MAXATASE[®], MAXACAL[®], PROPERASE[®] and MAXAPEM[®] all from Genencor International (formerly Gist-Brocades of The Netherlands).

Such proteolytic enzymes, when present, are incorporated in the cleaning compositions of the present invention a level of from 0.0001% to 2%, preferably from 0.001% to 0.2%, more preferably from 0.005% to 0.1% pure enzyme by weight of the composition.

Amylases (α and/or β) can be included for removal of carbohydrate-based stains. WO94/02597 describes cleaning compositions which incorporate mutant amylases. See also WO95/10603. Other amylases known for use in cleaning compositions include both α - and β -amylases. α -Amylases are known in the art and include those disclosed in US Pat. no. 5,003,257; EP 252,666; WO/91/00353; FR 2,676,456; EP 285,123; EP 525,610; EP 368,341; and British Patent specification no. 1,296,839 (Novo). Other suitable amylases are stability-enhanced amylases described in WO94/18314 and WO96/05295, Genencor, and amylase variants having additional modification in the immediate parent available from Novo Nordisk A/S, disclosed in WO 95/10603. Also suitable are amylases described in EP 277 216.

Examples of commercial α -amylases products are Purafect Ox Am[®] from Genencor and Termamyl[®], Ban[®], Fungamyl[®] and Duramyl[®], all available from Novo Nordisk A/S Denmark. WO95/26397 describes other suitable amylases : α -amylases characterised by having a specific activity at least 25% higher than the specific activity of Termamyl[®] at a temperature range of 25°C to 55°C and at a pH value in the range of 8 to 10, measured by the Phadebas[®] α -amylase activity assay. Suitable are variants of the above enzymes, described in WO96/23873 (Novo Nordisk). Other amylolytic enzymes with improved properties with respect to the activity level and the combination of thermostability and a higher activity level are described in WO95/35382.

Such amylolytic enzymes, when present, are incorporated in the cleaning compositions of the present invention a level of from 0.0001% to 2%, preferably from 0.00018% to 0.06%, more preferably from 0.00024% to 0.048% pure enzyme by weight of the composition.

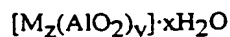
The above-mentioned enzymes may be of any suitable origin, such as vegetable, animal, bacterial, fungal and yeast origin. Origin can further be mesophilic or extremophilic

preferably from about 10% to 70% by weight, most preferably from about 20% to 60% by weight of the composition.

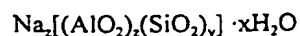
Crystalline layered sodium silicates having the general formula $\text{NaMSi}_x\text{O}_{2x+1} \cdot y\text{H}_2\text{O}$ wherein M is sodium or hydrogen, x is a number from about 1.9 to about 4, preferably from about 2 to about 4, most preferably 2, and y is a number from about 0 to about 20, preferably 0 can be used in the compositions described herein. Crystalline layered sodium silicates of this type are disclosed in EP-A-0164514 and methods for their preparation are disclosed in DE-A-3417649 and DE-A-3742043. The most preferred material is delta- Na_2SiO_5 , available from Hoechst AG as NaSKS-6 (commonly abbreviated herein as "SKS-6"). Unlike zeolite builders, the Na SKS-6 silicate builder does not contain aluminum. NaSKS-6 has the delta- Na_2SiO_5 morphology form of layered silicate. SKS-6 is a highly preferred layered silicate for use in the compositions described herein herein, but other such layered silicates, such as those having the general formula $\text{NaMSi}_x\text{O}_{2x+1} \cdot y\text{H}_2\text{O}$ wherein M is sodium or hydrogen, x is a number from 1.9 to 4, preferably 2, and y is a number from 0 to 20, preferably 0 can be used in the compositions described herein. Various other layered silicates from Hoechst include NaSKS-5, NaSKS-7 and NaSKS-11, as the alpha, beta and gamma forms. As noted above, the delta- Na_2SiO_5 (NaSKS-6 form) is most preferred for use herein. Other silicates may also be useful such as for example magnesium silicate, which can serve as a crispening agent in granular formulations, as a stabilizing agent for oxygen bleaches, and as a component of suds control systems.

The crystalline layered sodium silicate material is preferably present in granular detergent compositions as a particulate in intimate admixture with a solid, water-soluble ionizable material. The solid, water-soluble ionizable material is preferably selected from organic acids, organic and inorganic acid salts and mixtures thereof.

Aluminosilicate builders are of great importance in most currently marketed heavy duty granular detergent compositions, and can also be a significant builder ingredient in liquid detergent formulations. Aluminosilicate builders have the empirical formula:



wherein z and y are integers of at least 6, the molar ratio of z to y is in the range from 1.0 to about 0.5, and x is an integer from about 15 to about 264. Preferably, the aluminosilicate builder is an aluminosilicate zeolite having the unit cell formula:



wherein z and y are at least 6; the molar ratio of z to y is from 1.0 to 0.5 and x is at least 5, preferably 7.5 to 276, more preferably from 10 to 264. The aluminosilicate builders are preferably in hydrated form and are preferably crystalline, containing from about 10% to about 28%, more preferably from about 18% to about 22% water in bound form.

Builders - The detergent and cleaning compositions described herein preferably comprise one or more detergent builders or builder systems. When present, the compositions will typically comprise at least about 1% builder, preferably from about 5%, more preferably from about 10% to about 80%, preferably to about 50%, more preferably to about 30% by weight, of detergent builder. Lower or higher levels of builder, however, are not meant to be excluded.

Preferred builders for use in the detergent and cleaning compositions, particularly dishwashing compositions, described herein include, but are not limited to, water-soluble builder compounds, (for example polycarboxylates) as described in U.S. Patent Nos. 5,695,679, 5,705,464 and 5,710,115. Other suitable polycarboxylates are disclosed in U.S. Patent Nos. 4,144,226, 3,308,067 and 3,723,322. Preferred polycarboxylates are hydroxycarboxylates containing up to three carboxy groups per molecule, more particularly titrates.

Inorganic or P-containing detergent builders include, but are not limited to, the alkali metal, ammonium and alkanolammonium salts of polyphosphates (exemplified by the tripolyphosphates, pyrophosphates, and glassy polymeric meta-phosphates), phosphonates (see, for example, U.S. Patent Nos. 3,159,581; 3,213,030; 3,422,021; 3,400,148 and 3,422,137), phytic acid, silicates, carbonates (including bicarbonates and sesquicarbonates), sulphates, and aluminosilicates.

However, non-phosphate builders are required in some locales. Importantly, the compositions herein function surprisingly well even in the presence of the so-called "weak" builders (as compared with phosphates) such as citrate, or in the so-called "underbuilt" situation that may occur with zeolite or layered silicate builders.

Suitable silicates include the water-soluble sodium silicates with an $\text{SiO}_2:\text{Na}_2\text{O}$ ratio of from about 1.0 to 2.8, with ratios of from about 1.6 to 2.4 being preferred, and about 2.0 ratio being most preferred. The silicates may be in the form of either the anhydrous salt or a hydrated salt. Sodium silicate with an $\text{SiO}_2:\text{Na}_2\text{O}$ ratio of 2.0 is the most preferred. Silicates, when present, are preferably present in the detergent and cleaning compositions described herein at a level of from about 5% to about 50% by weight of the composition, more preferably from about 10% to about 40% by weight.

Partially soluble or insoluble builder compounds, which are suitable for use in the detergent and cleaning compositions, particularly granular detergent compositions, include, but are not limited to, crystalline layered silicates, preferably crystalline layered sodium silicates (partially water-soluble) as described in U.S. Patent No. 4,664,839, and sodium aluminosilicates (water-insoluble). When present in detergent and cleaning compositions, these builders are typically present at a level of from about 1% to 80% by weight,

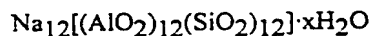
dispersent or anti-redeposition agent can be used in the laundry compositions of the present invention.

In addition, polymeric dispersing agents which include polymeric polycarboxylates and polyethylene glycols, are suitable for use in the present invention. Unsaturated monomeric acids that can be polymerized to form suitable polymeric polycarboxylates include acrylic acid, maleic acid (or maleic anhydride), fumaric acid, itaconic acid, aconitic acid, mesaconic acid, citraconic acid and methylenemalononic acid. Particularly suitable polymeric polycarboxylates can be derived from acrylic acid. Such acrylic acid-based polymers which are useful herein are the water-soluble salts of polymerized acrylic acid. The average molecular weight of such polymers in the acid form preferably ranges from about 2,000 to 10,000, more preferably from about 4,000 to 7,000 and most preferably from about 4,000 to 5,000. Water-soluble salts of such acrylic acid polymers can include, for example, the alkali metal, ammonium and substituted ammonium salts. Soluble polymers of this type are known materials. Use of polyacrylates of this type in detergent compositions has been disclosed, for example, in U.S. 3,308,067.

Acrylic/maleic-based copolymers may also be used as a preferred component of the dispersing/anti-redeposition agent. Such materials include the water-soluble salts of copolymers of acrylic acid and maleic acid. The average molecular weight of such copolymers in the acid form preferably ranges from about 2,000 to 100,000, more preferably from about 5,000 to 75,000, most preferably from about 7,000 to 65,000. The ratio of acrylate to maleate segments in such copolymers will generally range from about 30:1 to about 1:1, more preferably from about 10:1 to 2:1. Water-soluble salts of such acrylic acid/maleic acid copolymers can include, for example, the alkali metal, ammonium and substituted ammonium salts. Soluble acrylate/maleate copolymers of this type are known materials which are described in European Patent Application No. 66915, published December 15, 1982, as well as in EP 193,360, published September 3, 1986, which also describes such polymers comprising hydroxypropylacrylate. Still other useful dispersing agents include the maleic/acrylic/vinyl alcohol terpolymers. Such materials are also disclosed in EP 193,360, including, for example, the 45/45/10 terpolymer of acrylic/maleic/vinyl alcohol.

Another polymeric material which can be included is polyethylene glycol (PEG). PEG can exhibit dispersing agent performance as well as act as a clay soil removal-antiredeposition agent. Typical molecular weight ranges for these purposes range from about 500 to about 100,000, preferably from about 1,000 to about 50,000, more preferably from about 1,500 to about 10,000.

These aluminosilicate ion exchange materials can be crystalline or amorphous in structure and can be naturally-occurring aluminosilicates or synthetically derived. A method for producing aluminosilicate ion exchange materials is disclosed in U.S. 3,985,669. Preferred synthetic crystalline aluminosilicate ion exchange materials useful herein are available under the designations Zeolite A, Zeolite B, Zeolite P, Zeolite X, Zeolite MAP and Zeolite HS and mixtures thereof. In an especially preferred embodiment, the crystalline aluminosilicate ion exchange material has the formula:



wherein x is from about 20 to about 30, especially about 27. This material is known as Zeolite A. Dehydrated zeolites ($x = 0 - 10$) may also be used herein. Preferably, the aluminosilicate has a particle size of about 0.1-10 microns in diameter. Zeolite X has the formula:



Citrate builders, e.g., citric acid and soluble salts thereof (particularly sodium salt), are polycarboxylate builders of particular importance for heavy duty liquid detergent formulations due to their availability from renewable resources and their biodegradability. Citrates can also be used in granular compositions, especially in combination with zeolite and/or layered silicate builders. Oxydisuccinates are also especially useful in such compositions and combinations.

Also suitable in the detergent compositions described herein are the 3,3-dicarboxy-4-oxa-1,6-hexanedioates and the related compounds disclosed in U.S. 4,566,984. Useful succinic acid builders include the C_5 - C_{20} alkyl and alkenyl succinic acids and salts thereof. A particularly preferred compound of this type is dodecenylsuccinic acid. Specific examples of succinate builders include: laurylsuccinate, myristylsuccinate, palmitylsuccinate, 2-dodecenylsuccinate (preferred), 2-pentadecenylsuccinate, and the like. Laurylsuccinates are the preferred builders of this group, and are described in European Patent Application 86200690.5/0,200,263, published November 5, 1986.

Fatty acids, e.g., C_{12} - C_{18} monocarboxylic acids, can also be incorporated into the compositions alone, or in combination with the aforesaid builders, especially citrate and/or the succinate builders, to provide additional builder activity. Such use of fatty acids will generally result in a diminution of sudsing, which should be taken into account by the formulator.

Dispersants - One or more suitable polyalkyleneimine dispersants may be incorporated into the cleaning compositions of the present invention. Examples of such suitable dispersants can be found in European Patent Application Nos. 111,965, 111,984, and 112,592; U.S. Patent Nos. 4,597,898, 4,548,744, and 5,565,145. However, any suitable clay/soil

ammonium salts are disclosed in EP-B-026 527 and EP-B-026 528 and di-long-chain amides as disclosed in EP-B-0 242 919. Other useful organic ingredients of fabric softening systems include high molecular weight polyethylene oxide materials as disclosed in EP-A-0 299 575 and 0 313 146.

Particularly suitable fabric softening agents are disclosed in U.S. Patent Nos. 5,707,950 and 5,728,673.

Levels of smectite clay are normally in the range from 2% to 20%, more preferably from 5% to 15% by weight, with the material being added as a dry mixed component to the remainder of the formulation. Organic fabric softening agents such as the water-insoluble tertiary amines or dilong chain amide materials are incorporated at levels of from 0.5% to 5% by weight, normally from 1% to 3% by weight whilst the high molecular weight polyethylene oxide materials and the water soluble cationic materials are added at levels of from 0.1% to 2%, normally from 0.15% to 1.5% by weight. These materials are normally added to the spray dried portion of the composition, although in some instances it may be more convenient to add them as a dry mixed particulate, or spray them as molten liquid on to other solid components of the composition.

Biodegradable quaternary ammonium compounds as described in EP-A-040 562 and EP-A-239 910 have been presented as alternatives to the traditionally used di-long alkyl chain ammonium chlorides and methyl sulfates.

Non-limiting examples of softener-compatible anions for the quaternary ammonium compounds and amine precursors include chloride or methyl sulfate.

Dye transfer inhibition - The detergent compositions of the present invention can also include compounds for inhibiting dye transfer from one fabric to another of solubilized and suspended dyes encountered during fabric laundering and conditioning operations involving colored fabrics.

Polymeric dye transfer inhibiting agents

The detergent compositions according to the present invention can also comprise from 0.001% to 10 %, preferably from 0.01% to 2%, more preferably from 0.05% to 1% by weight of polymeric dye transfer inhibiting agents. Said polymeric dye transfer inhibiting agents are normally incorporated into detergent compositions in order to inhibit the transfer of dyes from colored fabrics onto fabrics washed therewith. These polymers have the ability to complex or adsorb the fugitive dyes washed out of dyed fabrics before the dyes have the opportunity to become attached to other articles in the wash.

Especially suitable polymeric dye transfer inhibiting agents are polyamine N-oxide polymers, copolymers of N-vinylpyrrolidone and N-vinylimidazole, polyvinylpyrrolidone polymers, polyvinylloxazolidones and polyvinylimidazoles or mixtures thereof. Examples

Polyaspartate and polyglutamate dispersing agents may also be used, especially in conjunction with zeolite builders. Dispersing agents such as polyaspartate preferably have a molecular weight (avg.) of about 10,000.

Soil Release Agents - The compositions according to the present invention may optionally comprise one or more soil release agents. If utilized, soil release agents will generally comprise from about 0.01%, preferably from about 0.1%, more preferably from about 0.2% to about 10%, preferably to about 5%, more preferably to about 3% by weight, of the composition. Nonlimiting examples of suitable soil release polymers are disclosed in: U.S. Patent Nos. 5,728,671; 5,691,298; 5,599,782; 5,415,807; 5,182,043; 4,956,447; 4,976,879; 4,968,451; 4,925,577; 4,861,512; 4,877,896; 4,771,730; 4,711,730; 4,721,580; 4,000,093; 3,959,230; and 3,893,929; and European Patent Application 0 219 048.

Further suitable soil release agents are described in U.S. Patent Nos. 4,201,824; 4,240,918; 4,525,524; 4,579,681; 4,220,918; and 4,787,989; EP 279,134 A; EP 457,205 A; and DE 2,335,044.

Chelating Agents - The compositions of the present invention herein may also optionally contain a chelating agent which serves to chelate metal ions and metal impurities which would otherwise tend to deactivate the bleaching agent(s). Useful chelating agents can include amino carboxylates, phosphonates, amino phosphonates, polyfunctionally-substituted aromatic chelating agents and mixtures thereof. Further examples of suitable chelating agents and levels of use are described in U.S. Pat. Nos. 5,705,464, 5,710,115, 5,728,671 and 5,576,282.

The compositions herein may also contain water-soluble methyl glycine diacetic acid (MGDA) salts (or acid form) as a chelant or co-builder useful with, for example, insoluble builders such as zeolites, layered silicates and the like.

If utilized, these chelating agents will generally comprise from about 0.1% to about 15%, more preferably from about 0.1% to about 3.0% by weight of the detergent compositions herein.

Suds suppressor - Another optional ingredient is a suds suppressor, exemplified by silicones, and silica-silicone mixtures. Examples of suitable suds suppressors are disclosed in U.S. Patent Nos. 5,707,950 and 5,728,671. These suds suppressors are normally employed at levels of from 0.001% to 2% by weight of the composition, preferably from 0.01% to 1% by weight.

Softening agents - Fabric softening agents can also be incorporated into laundry detergent compositions in accordance with the present invention. Inorganic softening agents are exemplified by the smectite clays disclosed in GB-A-1 400 898 and in U.S. 5,019,292. Organic softening agents include the water insoluble tertiary amines as disclosed in GB-A-1 514 276 and EP-B-011 340 and their combination with mono C12-C14 quaternary

dyes, fillers, germicides, alkalinity sources, hydrotropes, anti-oxidants, perfumes, solubilizing agents, carriers, processing aids, pigments, and pH control agents as described in U.S. Patent Nos. 5,705,464, 5,710,115, 5,698,504, 5,695,679, 5,686,014 and 5,646,101.

Methods of Cleaning - In addition to the methods for cleaning fabrics, dishes and other hard surfaces, and body parts by personal cleansing, described herein, the invention herein also encompasses a laundering pretreatment process for fabrics which have been soiled or stained comprising directly contacting said stains and/or soils with a highly concentrated form of the cleaning composition set forth above prior to washing such fabrics using conventional aqueous washing solutions. Preferably, the cleaning composition remains in contact with the soil/stain for a period of from about 30 seconds to 24 hours prior to washing the pretreated soiled/stained substrate in conventional manner. More preferably, pretreatment times will range from about 1 to 180 minutes.

The following examples are meant to exemplify compositions of the present invention, but are not necessarily meant to limit or otherwise define the scope of the invention.

In all of the following examples Protease¹ means a protease variant comprising substitution of amino acid residues with another naturally occurring amino acid residue at positions corresponding to positions 101G/103A/104I/159D/232V/236H/245R/248D/252K of *Bacillus amyloliquefaciens* subtilisin. Protease¹ can be substituted with any other additional protease variant of the present invention, with substantially similar results in the following examples.

In the cleaning composition examples of the present invention, the Protease¹ enzyme levels are expressed by pure enzyme by weight of the total composition, the other enzyme levels are expressed by raw material by weight of the total composition, and unless otherwise specified, the other ingredients are expressed by weight of the total composition.

Further, in all of the following examples Amylase³ means an amylase variant according to the present invention.

Further, in the following examples some abbreviations known to those of ordinary skill in the art are used, consistent with the disclosure set forth herein.

of such dye transfer inhibiting agents are disclosed in U.S. Patent Nos. 5,707,950 and 5,707,951.

Additional suitable dye transfer inhibiting agents include, but are not limited to, cross-linked polymers. Cross-linked polymers are polymers whose backbone are interconnected to a certain degree; these links can be of chemical or physical nature, possibly with active groups in the backbone or on branches; cross-linked polymers have been described in the Journal of Polymer Science, volume 22, pages 1035-1039.

In one embodiment, the cross-linked polymers are made in such a way that they form a three-dimensional rigid structure, which can entrap dyes in the pores formed by the three-dimensional structure. In another embodiment, the cross-linked polymers entrap the dyes by swelling. Such cross-linked polymers are described in the co-pending European patent application 94870213.9.

Addition of such polymers also enhances the performance of the enzymes according to the invention.

pH and Buffering Variation - Many of the detergent and cleaning compositions described herein will be buffered, i.e., they are relatively resistant to pH drop in the presence of acidic soils. However, other compositions herein may have exceptionally low buffering capacity, or may be substantially unbuffered. Techniques for controlling or varying pH at recommended usage levels more generally include the use of not only buffers, but also additional alkalis, acids, pH-jump systems, dual compartment containers, etc., and are well known to those skilled in the art.

The preferred ADD compositions herein comprise a pH-adjusting component selected from water-soluble alkaline inorganic salts and water-soluble organic or inorganic builders as described in U.S. Patent Nos. 5,705,464 and 5,710,115.

Material Care Agents - The preferred ADD compositions may contain one or more material care agents which are effective as corrosion inhibitors and/or anti-tarnish aids as described in U.S. Patent Nos. 5,705,464, 5,710,115 and 5,646,101.

When present, such protecting materials are preferably incorporated at low levels, e.g., from about 0.01% to about 5% of the ADD composition.

Other Materials - Detergent ingredients or adjuncts optionally included in the instant compositions can include one or more materials for assisting or enhancing cleaning performance, treatment of the substrate to be cleaned, or designed to improve the aesthetics of the compositions. Adjuncts which can also be included in compositions of the present invention, at their conventional art-established levels for use (generally, adjunct materials comprise, in total, from about 30% to about 99.9%, preferably from about 70% to about 95%, by weight of the compositions), include other active ingredients such as non-phosphate builders, color speckles, silvercare, anti-tarnish and/or anti-corrosion agents,

Examples 2-7
Dishwashing Composition

| Component | Example No. | | | | | |
|--|-----------------|-------|--------|-------|--------|-------|
| | 2 | 3 | 4 | 5 | 6 | 7 |
| Protease ¹ | 0.05 | 0.50 | 0.02 | 0.40 | 0.10 | 0.03 |
| Protease ² | - | - | - | - | 0.40 | 0.1 |
| Amylase ³ | 0.002 | 0.002 | 0.0005 | 0.04 | 0.0008 | 0.005 |
| TFAA I | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| AES | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 |
| 2-methyl undecanoic acid | 4.50 | 4.50 | -- | 4.50 | 4.50 | -- |
| C ₁₂ ethoxy (2) carboxylate | 4.50 | 4.50 | 4.50 | 4.50 | 4.50 | 4.50 |
| C ₁₂ alcohol ethoxylate (4) | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Amine oxide | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Hydrotrope | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Ethanol | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| Mg ⁺⁺ (as MgCl ₂) | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Ca ⁺⁺ (as CaCl ₂) | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 |
| Water and Minors**** | balance to 100% | | | | | |

² Protease other than the Protease¹ including but not limited to the additional proteases useful in the present invention described herein.

**** Product pH is adjusted to 7.

In Examples 6 and 7, any combination of the protease enzymes useful in the present invention recited herein, among others, are substituted for Protease¹ and Protease², with substantially similar results.

Example 8
Dishwashing Compositions (A&B ADW: C Liquid)

| Component | A | B | C |
|-------------------------------|------|------|---|
| STPP | 17.5 | - | - |
| Citrate | | 15.0 | - |
| Sodium polyacrylate (MW 4500) | 0.80 | - | - |
| Acusol 480N | - | 5.10 | - |
| Potassium carbonate | 8.30 | - | - |
| Sodium carbonate | - | 8.50 | - |
| 2.1r K Silicate | 3.99 | - | - |
| 2.0r Na Silicate | 2.00 | - | - |

Examples 1-7
Liquid Hard Surface Cleaning Compositions

| Component | Example No. | | | | | | |
|------------------------|-----------------|-------|-------|--------|------|--------|-------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Protease ¹ | 0.05 | 0.05 | 0.20 | 0.02 | 0.03 | 0.10 | 0.03 |
| Protease ² | - | - | - | - | - | 0.20 | 0.1 |
| Amylase ³ | - | 0.002 | 0.002 | 0.0005 | 0.04 | 0.0008 | 0.005 |
| Chelant ^{**} | - | - | - | 2.90 | 2.90 | - | - |
| Citrate | - | - | - | - | - | 2.90 | 2.90 |
| LAS | - | 1.95 | - | 1.95 | - | 1.95 | - |
| AS | 2.00 | - | 2.20 | - | 2.20 | - | 2.20 |
| AES | 2.00 | - | 2.20 | - | 2.20 | - | 2.20 |
| Amine Oxide | 0.40 | - | 0.50 | - | 0.50 | - | 0.50 |
| Hydrotrope | - | 1.30 | - | 1.30 | - | 1.30 | - |
| Solvent ^{***} | - | 6.30 | 6.30 | 6.30 | 6.30 | 6.30 | 6.30 |
| Water and Minors | balance to 100% | | | | | | |

² Protease other than the Protease¹ including but not limited to the additional proteases useful in the present invention described herein.

^{**}Na₄ ethylenediamine diacetic acid

^{***}Diethyleneglycol monohexyl ether

^{****}All formulas adjusted to pH 7

In Examples 6 and 7, any combination of the protease enzymes useful in the present invention recited herein, among others, are substituted for Protease¹ and Protease², with substantially similar results.

Example 10Granular Automatic Dishwashing Composition

| <u>Component</u> | <u>A</u> | <u>B</u> | <u>C</u> |
|---|-----------------|----------|----------|
| Citric Acid | 15.0 | - | - |
| Citrate | 4.0 | 29.0 | 15.0 |
| Acrylate/methacrylate copolymer | 6.0 | - | 6.0 |
| Acrylic acid maleic acid copolymer | - | 3.7 | - |
| Dry add carbonate | 9.0 | - | 20.0 |
| Alkali metal silicate | 8.5 | 17.0 | 9.0 |
| Paraffin | - | 0.5 | - |
| Benzotriazole | - | 0.3 | - |
| Amylase ³ | 1.6 | 1.6 | 1.6 |
| Protease ¹ | 0.2 | 0.1 | 0.06 |
| Percarbonate (AvO) | 1.5 | - | - |
| Perborate monohydrate | - | 0.3 | 1.5 |
| Perborate tetrahydrate | - | 0.9 | - |
| Tetraacetylene diamine | 3.8 | 4.4 | - |
| Diethylene triamine penta methyl phosphonic acid (Mg salt) | 0.13 | 0.13 | 0.13 |
| Alkyl ethoxy sulphate - 3 times ethoxylated | 3.0 | - | - |
| Alkyl ethoxy propoxy nonionic surfactant | - | 1.5 | - |
| Suds suppressor | 2.0 | - | - |
| Olin SLF18 nonionic surfactant | - | - | 2.0 |
| Sulphate | Balance to 100% | | |

Example 11

Compact high density (0.96Kg/l) dishwashing detergent compositions A to F in accordance with the invention:

| <u>Component</u> | <u>A</u> | <u>B</u> | <u>C</u> | <u>D</u> | <u>E</u> | <u>F</u> |
|------------------|----------|----------|----------|----------|----------|----------|
| STPP | - | 51.4 | 51.4 | - | - | 44.3 |
| Citrate | 17.05 | - | - | 49.6 | 40.2 | - |
| Carbonate | 17.50 | 14.0 | 20.0 | - | 8.0 | 33.6 |
| Bicarbonate | - | - | - | 26.0 | - | - |
| Silicate | 14.81 | 15.0 | 8.0 | - | 25.0 | 3.6 |
| Metasilicate | 2.50 | 4.5 | 4.5 | - | - | - |
| PB1 | 9.74 | 7.79 | 7.79 | - | - | - |
| PB4 | - | - | - | 9.6 | - | - |

| | | | |
|--|-------|------|-------|
| 3.2r Na Silicate | 5.18 | - | - |
| Aluminum tristearate | 0.10 | - | - |
| Nonionic surfactant | - | 2.50 | - |
| NaAE0.6S | - | - | 24.70 |
| Glucose amide | - | - | 3.09 |
| C10E8 | - | - | 4.11 |
| Betaine | - | - | 2.06 |
| Amine oxide | - | - | 2.06 |
| Magnesium as oxide | - | - | 0.49 |
| Hydrotrope | - | - | 4.47 |
| Sodium hypochlorite as AvCl_2 | 1.15 | - | - |
| Amylase ³ | 0.002 | 0.03 | 0.005 |
| Protease ¹ | 0.01 | 0.43 | 0.05 |
| Balance to 100% | | | |

Example 9Liquid Dishwashing Compositions (especially suitable under Japanese conditions)

| Component | A | B |
|-----------------------------|-------|-----------|
| AE1.4S | 24.69 | 24.69 |
| N-cocoyl N-methyl glucamine | 3.09 | 3.09 |
| Amine oxide | 2.06 | 2.06 |
| Betaine | 2.06 | 2.06 |
| Nonionic surfactant | 4.11 | 4.11 |
| Hydrotrope | 4.47 | 4.47 |
| Magnesium | 0.49 | 0.49 |
| Ethanol | 7.2 | 7.2 |
| LemonEase | 0.45 | 0.45 |
| Geraniol/BHT | - | 0.60/0.02 |
| Amylase ³ | 0.03 | 0.005 |
| Protease ¹ | 0.01 | 0.43 |
| Balance to 100% | | |

| | | | | | | |
|------------------|-------|------|------|-------|------|------|
| pH (1% solution) | 10.80 | 11.3 | 11.0 | 10.70 | 11.5 | 10.9 |
|------------------|-------|------|------|-------|------|------|

Example 13

Tablet detergent composition examples A to H in accordance with the present invention are prepared by compression of a granular dishwashing detergent composition at a pressure of 13KN/cm² using a standard 12 head rotary press:

| Component | A | B | C | D | E | F | G | H |
|-----------------------|------|------|-------|-------|-------|------|------|------|
| STPP | - | 48.8 | 54.7 | 38.2 | - | 52.4 | 56.1 | 36.0 |
| Citrate | 20.0 | - | - | - | 35.9 | - | - | - |
| Carbonate | 20.0 | 5.0 | 14.0 | 15.4 | 8.0 | 23.0 | 20.0 | 28.0 |
| Silicate | 15.0 | 14.8 | 15.0 | 12.6 | 23.4 | 2.9 | 4.3 | 4.2 |
| Protease ¹ | 0.05 | 0.09 | 0.05 | 0.03 | 0.06 | 0.03 | 0.03 | 0.1 |
| Amylase ³ | 1.5 | 1.5 | 1.5 | 0.85 | 1.9 | 0.4 | 2.1 | 0.3 |
| PB1 | 14.3 | 7.8 | 11.7 | 12.2 | - | - | 6.7 | 8.5 |
| PB4 | - | - | - | - | 22.8 | - | 3.4 | - |
| Percarbonate | - | - | - | - | - | 10.4 | - | - |
| Nonionic | 1.5 | 2.0 | 2.0 | 2.2 | 1.0 | 4.2 | 4.0 | 6.5 |
| PAAC | - | - | 0.016 | 0.009 | - | - | - | - |
| MnTACN | - | - | - | - | 0.007 | - | - | - |
| TAED | 2.7 | 2.4 | - | - | - | 2.1 | 0.7 | 1.6 |
| HEDP | 1.0 | - | - | 0.93 | - | 0.4 | 0.2 | - |
| DETPMP | 0.7 | - | - | - | - | - | - | - |
| Paraffin | 0.4 | 0.5 | 0.5 | 0.55 | - | - | 0.5 | - |
| BTA | 0.2 | 0.3 | 0.3 | 0.33 | 0.3 | 0.3 | 0.3 | - |
| Polycarboxylate | 4.0 | - | - | - | 4.9 | 0.6 | 0.8 | - |
| PEG | - | - | - | - | - | 2.0 | - | 2.0 |
| Glycerol | - | - | - | - | - | 0.4 | - | 0.5 |
| Perfume | - | - | - | 0.05 | 0.20 | 0.2 | 0.2 | 0.2 |
| Sulphate / water | 17.4 | 14.7 | - | 15.74 | - | - | - | 11.3 |
| weight of tablet | 20g | 25g | 20g | 30g | 18g | 20g | 25g | 24.0 |
| pH (1% solution) | 10.7 | 10.6 | 10.7 | 10.7 | 10.9 | 11.2 | 11.0 | 10.8 |

| | | | | | | |
|-----------------------|-------|-------|-------|------|-------|------|
| Percarbonate | - | - | - | - | 11.8 | 4.8 |
| Nonionic | 2.00 | 1.50 | 1.50 | 2.6 | 1.9 | 5.9 |
| TAED | 2.39 | - | - | 3.8 | - | 1.4 |
| HEDP | 1.00 | - | - | - | - | - |
| DETPMP | 0.65 | - | - | - | - | - |
| Mn TACN | - | - | - | - | 0.008 | - |
| PAAC | - | 0.008 | 0.008 | - | - | - |
| Paraffin | 0.50 | 0.38 | 0.38 | 0.6 | - | - |
| Protease ¹ | 0.1 | 0.06 | 0.05 | 0.03 | 0.07 | 0.01 |
| Amylase ³ | 1.5 | 1.5 | 1.5 | 2.6 | 2.1 | 0.8 |
| BTA | 0.30 | 0.22 | 0.22 | 0.3 | 0.3 | 0.3 |
| Polycarboxylate | 6.0 | - | - | - | 4.2 | 0.9 |
| Perfume | 0.2 | 0.12 | 0.12 | 0.2 | 0.2 | 0.2 |
| Sulphate / Water | 20.57 | 1.97 | 2.97 | 3.6 | 4.5 | 3.9 |
| pH (1% solution) | 11.0 | 11.0 | 11.3 | 9.6 | 10.8 | 10.9 |

Example 12

Granular dishwashing detergent compositions examples A to F of bulk density

1.02Kg/L in accordance with the invention:

| Component | A | B | C | D | E | F |
|-----------------------|-------|-------|-------|-------|------|------|
| STPP | 30.00 | 33.5 | 27.9 | 29.62 | 33.8 | 22.0 |
| Carbonate | 30.50 | 30.50 | 30.5 | 23.00 | 34.5 | 45.0 |
| Silicate | 7.40 | 7.50 | 12.6 | 13.3 | 3.2 | 6.2 |
| Metasilicate | - | 4.5 | | | | |
| Percarbonate | - | - | | - | 4.0 | |
| PBI | 4.4 | 4.5 | 4.3 | - | - | |
| NaDCC | - | - | | 2.00 | - | 0.9 |
| Nonionic | 1.0 | 0.75 | 1.0 | 1.90 | 0.7 | 0.5 |
| TAED | 1.00 | - | | - | 0.9 | |
| PAAC | - | 0.004 | | - | - | |
| Paraffin | 0.25 | 0.25 | | - | - | |
| Protease ¹ | 0.05 | 0.06 | 0.025 | 0.1 | 0.02 | 0.07 |
| Amylase ³ | 0.38 | 0.64 | 0.46 | - | 0.6 | |
| BTA | 0.15 | 0.15 | | - | 0.2 | |
| Perfume | 0.2 | 0.2 | 0.05 | 0.1 | 0.2 | |
| Sulphate/water | 23.45 | 16.87 | 22.26 | 30.08 | 21.7 | 25.4 |

Example 15

Granular Fabric Cleaning Composition

| Component | Example No. | | | |
|--|-----------------|--------|-------|-------|
| | A | B | C | D |
| Protease ¹ | 0.10 | 0.20 | 0.03 | 0.05 |
| Protease ² | - | - | 0.2 | 0.15 |
| Amylase ³ | 0.002 | 0.0005 | 0.04 | 0.005 |
| C ₁₃ linear alkyl benzene sulfonate | 22.00 | 22.00 | 22.00 | 22.00 |
| Phosphate (as sodium tripolyphosphates) | 23.00 | 23.00 | 23.00 | 23.00 |
| Sodium carbonate | 23.00 | 23.00 | 23.00 | 23.00 |
| Sodium silicate | 14.00 | 14.00 | 14.00 | 14.00 |
| Zeolite | 8.20 | 8.20 | 8.20 | 8.20 |
| Chelant (diethylenetriamine-pentaacetic acid) | 0.40 | 0.40 | 0.40 | 0.40 |
| Sodium sulfate | 5.50 | 5.50 | 5.50 | 5.50 |
| Water | balance to 100% | | | |

² Protease other than the Protease¹ including but not limited to the additional proteases useful in the present invention described herein.

In Examples 15 C and D, any combination of the protease enzymes useful in the present invention recited herein, among others, are substituted for Protease¹ and Protease², with substantially similar results.

Example 16

Granular Fabric Cleaning Composition

| Component | Example No. | | | |
|---|-------------|--------|-------|-------|
| | A | B | C | D |
| Protease ¹ | 0.10 | 0.20 | 0.03 | 0.05 |
| Protease ² | - | - | 0.2 | 0.1 |
| Amylase ³ | 0.005 | 0.0005 | 0.04 | 0.002 |
| C ₁₂ alkyl benzene sulfonate | 12.00 | 12.00 | 12.00 | 12.00 |

Example 14Dimple Tablet Automatic Dishwashing Composition

| <u>Component</u> | <u>A (% R.M.)</u> | <u>B (g R.M.)</u> | <u>C (g R.M.)</u> |
|-----------------------------|-------------------|-------------------|-------------------|
| Tablet Body | | | |
| Sodium Carbonate | 15.348 | 3.500 | 5.25 |
| STPP (12% H ₂ O) | 46.482 | 10.600 | 9.93 |
| Gran HEDP | 0.789 | 0.180 | 0.28 |
| SKS 6 | 6.578 | 1.500 | 2.25 |
| 2 ratio Silicate | 7.016 | 1.600 | 1.65 |
| PB1 | 10.743 | 2.450 | 3.68 |
| Termamyl 2x PCA | 0.491 | 0.112 | .17 |
| Savinase | 0.526 | 0.120 | 0.18 |
| Plurafac | 3.508 | 0.800 | 0.9 |
| BTA | 0.263 | 0.060 | 0.09 |
| PEG | 1.140 | 0.260 | - |
| PEG 4000 | - | - | 0.39 |
| Winog | 0.439 | 0.100 | 0.15 |
| Perfume | 0.101 | 0.023 | 0.01 |
| Dimple Filling | | | |
| Citric Acid | 0.987 | 0.225 | 0.23 |
| Bicarbonate | 2.600 | 0.593 | 0.59 |
| Sandolan EHRL Dye | 0.007 | 0.0017 | 0.0017 |
| PEG 400/4000 | 0.395 | 0.090 | |
| PEG 400 | - | - | 0.02 |
| PEG 4000 | - | - | 0.08 |
| Protease ¹ | 0.05 | 0.268 | 0.27 |
| Amylase ³ | 1.412 | 0.322 | 0.32 |

Granular Fabric Cleaning Composition

The granular fabric cleaning compositions of the present invention contain an effective amount of one or more protease enzymes, preferably from about 0.001% to about 10%, more preferably, from about 0.005% to about 5%, more preferably from 0.01% to about 1% by weight of active protease enzyme of the composition. (See U.S. Patent No. 5,679,630 Examples).

| | | |
|-----------------------|-----------|-----------|
| Protease ¹ | 0.1 | 0.01 |
| Lipase | 0.36 | 0.40 |
| Amylase ³ | 0.30 | 0.30 |
| Sodium silicate | 2.00 | 2.50 |
| Sodium sulphate | 3.50 | 5.20 |
| Polyvinyl pyrrolidone | 0.30 | 0.50 |
| Perborate | 0.5 | 1 |
| Phenol sulphonate | 0.1 | 0.2 |
| Peroxidase | 0.1 | 0.1 |
| Minors | Up to 100 | Up to 100 |

Example 18Granular Fabric Cleaning Compositions

| <u>Components</u> | <u>Example No.</u> | |
|--|--------------------|-----------|
| | <u>A</u> | <u>B</u> |
| Sodium linear C ₁₂ alkyl benzene-sulfonate | 6.5 | 8.0 |
| Sodium sulfate | 15.0 | 18.0 |
| Zeolite A | 26.0 | 22.0 |
| Sodium nitrilotriacetate | 5.0 | 5.0 |
| Polyvinyl pyrrolidone | 0.5 | 0.7 |
| N,N'-dimethylacetylene diamine | 3.0 | 3.0 |
| Boric acid | 4.0 | - |
| Perborate | 0.5 | 1 |
| Phenol sulphonate | 0.1 | 0.2 |
| Protease ¹ | 0.02 | 0.05 |
| Amylase ³ | 0.005 | 0.002 |
| Fillers (e.g., silicates; carbonates; perfumes; water) | Up to 100 | Up to 100 |

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| | | | | |
|---|-----------------|-------|-------|-------|
| 2-butyl octanoic acid | 4.00 | 4.00 | 4.00 | 4.00 |
| C ₁₂ -C ₁₄ secondary (2,3) alkyl sulfate, | 5.00 | 5.00 | 5.00 | 5.00 |
| Na salt | | | | |
| Sodium citrate | 5.00 | 5.00 | 5.00 | 5.00 |
| Optical brightener | 0.10 | 0.10 | 0.10 | 0.10 |
| Sodium sulfate | 17.00 | 17.00 | 17.00 | 17.00 |
| Fillers, water, minors | balance to 100% | | | |

² Protease other than the Protease¹ including but not limited to the additional proteases useful in the present invention described herein.

In Examples 16 C and D, any combination of the protease enzymes useful in the present invention recited herein, among others, are substituted for Protease¹ and Protease², with substantially similar results.

Example 17

Granular Fabric Cleaning Compositions

| <u>Components</u> | <u>Example No.</u> | |
|---|--------------------|----------|
| | <u>A</u> | <u>B</u> |
| Linear alkyl benzene sulphonate | 11.4 | 10.70 |
| Tallow alkyl sulphate | 1.80 | 2.40 |
| C ₁₄₋₁₅ alkyl sulphate | 3.00 | 3.10 |
| C ₁₄₋₁₅ alcohol 7 times ethoxylated | 4.00 | 4.00 |
| Tallow alcohol 11 times ethoxylated | 1.80 | 1.80 |
| Dispersant | 0.07 | 0.1 |
| Silicone fluid | 0.80 | 0.80 |
| Trisodium citrate | 14.00 | 15.00 |
| Citric acid | 3.00 | 2.50 |
| Zeolite | 32.50 | 32.10 |
| Maleic acid acrylic acid copolymer | 5.00 | 5.00 |
| Diethylene triamine penta methylene phosphonic acid | 1.00 | 0.20 |

Example 20Granular Fabric Cleaning Composition

| <u>Component</u> | <u>Weight %</u> |
|---|-----------------|
| Linear alkyl benzene sulphonate | 7.6 |
| C ₁₆ -C ₁₈ alkyl sulfate | 1.3 |
| C ₁₄₋₁₅ alcohol 7 times ethoxylated | 4.0 |
| Coco-alkyl-dimethyl hydroxyethyl ammonium chloride | 1.4 |
| Dispersant | 0.07 |
| Silicone fluid | 0.8 |
| Trisodium citrate | 5.0 |
| Zeolite 4A | 15.0 |
| Maleic acid acrylic acid copolymer | 4.0 |
| Diethylene triamine penta methylene phosphonic acid | 0.4 |
| Perborate | 15.0 |
| Tetraacetylene diamine | 5.0 |
| Smectite clay | 10.0 |
| Poly (oxy ethylene) (MW 300,000) | 0.3 |
| Protease ¹ | 0.02 |
| Lipase | 0.2 |
| Amylase ³ | 0.3 |
| Cellulase | 0.2 |
| Sodium silicate | 3.0 |
| Sodium carbonate | 10.0 |
| Carboxymethyl cellulose | 0.2 |
| Brighteners | 0.2 |
| Water, perfume and minors | Up to 100 |

Example 19Compact Granular Fabric Cleaning Composition

| <u>Components</u> | <u>Weight %</u> |
|--|-----------------|
| Alkyl Sulphate | 8.0 |
| Alkyl Ethoxy Sulphate | 2.0 |
| Mixture of C25 and C45 alcohol 3 and 7 times ethoxylated | 6.0 |
| Polyhydroxy fatty acid amide | 2.5 |
| Zeolite | 17.0 |
| Layered silicate/citrate | 16.0 |
| Carbonate | 7.0 |
| Maleic acid acrylic acid copolymer | 5.0 |
| Soil release polymer | 0.4 |
| Carboxymethyl cellulose | 0.4 |
| Poly (4-vinylpyridine) -N-oxide | 0.1 |
| Copolymer of vinylimidazole and vinylpyrrolidone | 0.1 |
| PEG2000 | 0.2 |
| Protease ¹ | 0.03 |
| Lipase | 0.2 |
| Cellulase | 0.2 |
| Amylase ³ | 0.005 |
| Tetracetylene diamine | 6.0 |
| Percarbonate | 22.0 |
| Ethylene diamine disuccinic acid | 0.3 |
| Suds suppressor | 3.5 |
| Disodium-4,4'-bis (2-morpholino -4-anilino-s-triazin-6-ylamino) stilbene-2,2'-disulphonate | 0.25 |
| Disodium-4,4'-bis (2-sulfostyryl) biphenyl | 0.05 |
| Water, Perfume and Minors | Up to 100 |

Example 22Granular Fabric Cleaning Composition

| <u>Component</u> | <u>A</u> | <u>B</u> | <u>C</u> |
|--------------------------------|----------|----------|----------|
| Base Granule Components | | | |
| LAS/AS/AES (65/35) | 9.95 | - | - |
| LAS/AS/AES (70/30) | - | 12.05 | 7.70 |
| Alumino silicate | 14.06 | 15.74 | 17.10 |
| Sodium carbonate | 11.86 | 12.74 | 13.07 |
| Sodium silicate | 0.58 | 0.58 | 0.58 |
| NaPAA Solids | 2.26 | 2.26 | 1.47 |
| PEG Solids | 1.01 | 1.12 | 0.66 |
| Brighteners | 0.17 | 0.17 | 0.11 |
| DTPA | - | - | 0.70 |
| Sulfate | 5.46 | 6.64 | 4.25 |
| DC-1400 Deaerant | 0.02 | 0.02 | 0.02 |
| Moisture | 3.73 | 3.98 | 4.33 |
| Minors | 0.31 | 0.49 | 0.31 |
| B.O.T. Spray-on | | | |
| Nonionic surfactant | 0.50 | 0.50 | 0.50 |
| Agglomerate Components | | | |
| LAS/AS (25/75) | 11.70 | 9.60 | 10.47 |
| Alumino silicate | 13.73 | 11.26 | 12.28 |
| Carbonate | 8.11 | 6.66 | 7.26 |
| PEG 4000 | 0.59 | 0.48 | 0.52 |
| Moisture/Minors | 4.88 | 4.00 | 4.36 |
| Functional Additives | | | |
| Sodium carbonate | 7.37 | 6.98 | 7.45 |
| Perborate | 1.03 | 1.03 | 2.56 |
| AC Base Coating | - | 1.00 | - |
| NOBS | - | - | 2.40 |
| Soil release polymer | 0.41 | 0.41 | 0.31 |
| Cellulase | 0.33 | 0.33 | 0.24 |
| Protease ¹ | 0.1 | 0.05 | 0.15 |
| Amylase ³ | 0.002 | 0.005 | 0.04 |
| AE-Flake | 0.40 | 0.40 | 0.29 |
| Liquid Spray-on | | | |
| Perfume | 0.42 | 0.42 | 0.42 |

Example 21Granular Fabric Cleaning Composition

| <u>Component</u> | <u>Weight %</u> |
|---|-----------------|
| Linear alkyl benzene sulfonate | 6.92 |
| Tallow alkyl sulfate | 2.05 |
| C ₁₄₋₁₅ alcohol 7 times ethoxylated | 4.4 |
| C ₁₂₋₁₅ alkyl ethoxy sulfate - 3 times ethoxylated | 0.16 |
| Zeolite | 20.2 |
| Citrate | 5.5 |
| Carbonate | 15.4 |
| Silicate | 3.0 |
| Maleic acid acrylic acid copolymer | 4.0 |
| Carboxymethyl cellulase | 0.31 |
| Soil release polymer | 0.30 |
| Protease ¹ | 0.1 |
| Lipase | 0.36 |
| Cellulase | 0.13 |
| Amylase ³ | 0.005 |
| Perborate tetrahydrate | 11.64 |
| Perborate monohydrate | 8.7 |
| Tetraacetylene diamine | 5.0 |
| Diethylene tramine penta methyl phosphonic acid | 0.38 |
| Magnesium sulfate | 0.40 |
| Brightener | 0.19 |
| Perfume, silicone, suds suppressors | 0.85 |
| Minors | Up to 100 |

| | | |
|---|-------------|---------------|
| - Polymer | 0.34 | 0.18 |
| - Hexamethylene- diamine tetra-E24 ethoxylate, diquaternized with methyl chloride | 1.00 | 1.00 |
| Enzyme | | |
| - Protease ¹ | 0.03 | 0.03 |
| (% pure enzyme) | | |
| - Cellulase | 0.26 | 0.26 |
| - Amylase ² | 0.65 | 0.73 |
| - Lipase | 0.27 | 0.15 |
| Bleach | | |
| - TAED (100%) | 3.85 | 3.50 |
| - Phenolsulfonate ester of N-nonanoyl-6- aminocaproic acid | - | 2.75 |
| - Percarbonate | 16.20 | 18.30 |
| - HEDP | 0.48 | 0.48 |
| - EDDS | 0.30 | 0.30 |
| Miscellaneous | | |
| - Malic particle | | 2.20 + bicarb |
| - Brightener 15/49 | 0.077/0.014 | 0.07/0.014 |
| - Zinc phthalocyanine sulfonate | 0.0026 | 0.0026 |
| - Polydimethylsiloxane with trimethylsilyl end blocking units | 0.25 | 0.24 |
| - Soap | - | 1.00 |
| - Perfume | 0.45 | 0.55 |
| TOTAL | 100 | 100 |

Noionic spray-on
Minors

1.00

1.00

0.50

Up to 100

Example 23**Granular Fabric Cleaning Composition**

| | A | B |
|---|-------|-------|
| Surfactant | | |
| - Na LAS | 6.40 | - |
| - KLAS | - | 9.90 |
| - AS/AE3S | 6.40 | 4.39 |
| - TAS | 0.08 | 0.11 |
| - C24AE5 | 3.48 | - |
| - Genagen | - | 1.88 |
| - N-cocoyl N-methyl glucamine (lin) | 1.14 | 2.82 |
| - C8-10 dimethyl hydroxyethyl ammonium chloride | 1.00 | 1.40 |
| Builder | | |
| - Zeolite | 20.59 | 13.39 |
| - SKS-6 | 10.84 | 10.78 |
| - Citric Acid | 2.00 | - |
| Buffer | | |
| - Carbonate | 9.60 | 12.07 |
| - Bicarbonate | 2.00 | 2.00 |
| - Sulphate | 2.64 | - |
| - Silicate | 0.61 | 0.16 |
| Polymer | | |
| - Acrylic acid/maleic acid copolymer (Na) | 1.17 | 1.12 |
| - CMC | 0.45 | 0.24 |

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| | | |
|---|--------|--------|
| Amylase ³ | 0.64 | 0.73 |
| Cellulase | 0.13 | 0.26 |
| Bleach | | |
| TAED | 2.2 | 2.5 |
| Phenolsulfonate ester of N-nonanoyl-6-aminocaproic acid | - | 1.96 |
| Sodium Percarbonate | - | 13.1 |
| PB4 | 15.6 | - |
| EDDS | 0.17 | 0.21 |
| MgSO ₄ | 0.35 | 0.47 |
| HEDP | 0.15 | 0.34 |
| Miscellaneous | | |
| Brightener | 0.06 | 0.04 |
| - Zinc phthalocyanine sulfonate | 0.0015 | 0.0020 |
| - Polydimethylsiloxane with trimethylsilyl end blocking units | 0.04 | 0.14 |
| Soap | 0.5 | 0.7 |
| Perfume | 0.35 | 0.45 |
| Speckle | 0.5 | 0.6 |

Examples 25

Granular laundry detergent compositions 25 A-C are of particular utility under European machine wash conditions and are prepared in accordance with the invention:

| Component | A | B | C |
|-----------|-----|------|------|
| LAS | 7.0 | 5.61 | 4.76 |
| TAS | - | - | 1.57 |
| C45AS | 6.0 | 2.24 | 3.89 |
| C25E3S | 1.0 | 0.76 | 1.18 |
| C45E7 | | - | 2.0 |
| C25E3 | 4.0 | 5.5 | - |

Example 24Granular Fabric Cleaning Composition

| | A | B |
|--|------|------|
| | % | % |
| Surfactant | | |
| NaLAS | 6.8 | 0.4 |
| KLAS | - | 10.9 |
| FAS | 0.9 | 0.1 |
| AS | 0.6 | 1.5 |
| C25AE3S | 0.1 | - |
| AE5 | 4.2 | - |
| N-Cocoyl-N-Methyl Glucamine | - | 1.8 |
| Genagen | - | 1.2 |
| C8-10 dimethyl hydroxyethyl ammonium chloride | - | 1.0 |
| Builder | | |
| SKS-6 | 3.3 | 9.0 |
| Zeolite | 17.2 | 18.9 |
| Citric Acid | 1.5 | - |
| Buffer | | |
| Carbonate | 21.1 | 15.0 |
| Sodium Bicarbonate | - | 2.6 |
| Sulphate | 15.2 | 5.5 |
| Malic Acid | - | 2.9 |
| Silicate | 0.1 | - |
| Polymer | | |
| Acrylic acid/maleic acid copolymer (Na) | 2.2 | 0.9 |
| Hexamethylene-diamine tetra-E24 ethoxylate, diquaternized with methyl chloride | 0.5 | 0.7 |
| Polymer | 0.1 | 0.1 |
| CMC | 0.2 | 0.1 |
| Enzymes | | |
| Protease ¹ (% pure enzyme) | 0.02 | 0.05 |
| Lipase | 0.18 | 0.14 |

| | | | |
|--|------|------|------|
| Brightener 1 | 0.08 | 0.19 | 0.19 |
| Brightener 2 | - | 0.04 | 0.04 |
| Perfume | 0.3 | 0.3 | 0.3 |
| Effervescent granules (malic acid 40%, sodium bicarbonate 40%, sodium carbonate 20%) | 15 | 15 | 5 |
| Silicone antifoam | 0.5 | 2.4 | 2.4 |
| Minors/inerts to 100% | | | |

Example 26

The following formulations are examples of compositions in accordance with the invention, which may be in the form of granules or in the form of a tablet.

| Component | 26 |
|---|------|
| Base Product | |
| C45 AS/TAS | 3.0 |
| LAS | 8.0 |
| C25AE3S | 1.0 |
| NaSKS-6 | 9.0 |
| C25AE5/AE3 | 5.0 |
| Zeolite A | 10.0 |
| SKS-6 (I) (dry add) | 2.0 |
| MA/AA | 2.0 |
| Citric acid | 1.5 |
| EDDS | 0.5 |
| HEDP | 0.2 |
| PB1 | 10.0 |
| NACA OBS | 2.0 |
| TAED | 2.0 |
| Carbonate | 8.0 |
| Sulphate | 2.0 |
| Amylase ³ | 0.3 |
| Lipase | 0.2 |
| Protease ¹ | 0.02 |
| Minors (Brightener/SRP1/ CMC/Photobleach/ MgSO4/ PVPVI/Suds suppressor/ PEG) | 0.5 |

| | | | |
|-----------------------------|--------|--------|--------|
| QAS | 0.8 | 2.0 | 2.0 |
| STPP | | - | - |
| Zeolite A | 25.0 | 19.5 | 19.5 |
| Citric acid | 2.0 | 2.0 | 2.0 |
| NaSKS-6 | 8.0 | 10.6 | 10.6 |
| Carbonate I | 8.0 | 10.0 | 8.6 |
| MA/AA | 1.0 | 2.6 | 1.6 |
| CMC | 0.5 | 0.4 | 0.4 |
| PB4 | - | 12.7 | - |
| Percarbonate | - | - | 19.7 |
| TAED | | 3.1 | 5.0 |
| Citrate | 7.0 | - | - |
| DTPMP | 0.25 | 0.2 | 0.2 |
| HEDP | 0.3 | 0.3 | 0.3 |
| QEA I | 0.9 | 1.2 | 1.0 |
| Protease ¹ | 0.02 | 0.05 | 0.035 |
| Lipase | 0.15 | 0.25 | 0.15 |
| Cellulase | 0.28 | 0.28 | 0.28 |
| Amylase | 0.4 | 0.7 | 0.3 |
| PVPI/ PVNO | 0.4 | - | 0.1 |
| Photoactivated bleach (ppm) | 15 ppm | 27 ppm | 27 ppm |

| | | | | | |
|---------------------------------|------|------|------|------|------|
| Sodium percarbonate | - | 4.21 | - | 3.16 | 3.16 |
| SRP | 0.52 | 0.52 | 0.70 | 0.70 | 0.70 |
| Brightener | 0.31 | 0.31 | 0.28 | 0.28 | 0.50 |
| AE-coflake | 0.17 | 0.20 | 0.17 | 0.17 | 0.17 |
| Polydimethylsiloxane | - | - | 0.68 | 0.68 | 0.68 |
| Perfume | 0.06 | 0.06 | 0.08 | - | - |
| Perfume | - | - | - | 0.23 | 0.23 |
| Hydrophobic precipitated silica | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| PEG4000 | 0.19 | 0.19 | 0.17 | 0.17 | 0.17 |
| Minors/inerts to 100% | | | | | |

Liquid Fabric Cleaning Compositions

Liquid fabric cleaning compositions of the present invention preferably comprise an effective amount of one or more protease enzymes, preferably from about 0.0001% to about 10%, more preferably from about 0.001% to about 1%, and most preferably from about 0.001% to about 0.1% by weight of active protease enzyme of the composition. (See U.S. Patent No. 5,679,630 Examples).

Example 28

Liquid Fabric Cleaning Compositions

| Component | Example No. | | | | |
|---|-----------------|-------|-------|-------|-------|
| | A | B | C | D | E |
| Protease ¹ | 0.05 | 0.03 | 0.30 | 0.03 | 0.10 |
| Protease ² | - | - | - | 0.1 | 0.20 |
| Amylase ³ | | | | | |
| C ₁₂ - C ₁₄ alkyl sulfate, Na | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 2-Butyl octanoic acid | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Sodium citrate | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| C ₁₀ alcohol ethoxylate (3) | 13.00 | 13.00 | 13.00 | 13.00 | 13.00 |
| Monethanolamine | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 |
| Water/propylene glycol/ethanol (100:1:1) | balance to 100% | | | | |

| | |
|---------|-----|
| Perfume | 0.5 |
|---------|-----|

Example 27

The following granular laundry detergent compositions 27 A-E are of particular utility under Japanese machine wash conditions and are prepared in accord with the invention:

| Component | A | B | C | D | E |
|--|-------|-------|-------|-------|-------|
| LAS | 23.57 | 23.57 | 21.67 | 21.68 | 21.68 |
| FAS | 4.16 | 4.16 | 3.83 | 3.83 | 3.83 |
| Nonionic surfactant | 3.30 | 3.30 | 2.94 | 3.27 | 3.27 |
| Bis (hydroxyethyl) methyl alkyl ammonium chloride | 0.47 | 0.47 | 1.20 | 1.20 | 1.20 |
| SKS-6 | 7.50 | 7.50 | 5.17 | 5.76 | 5.06 |
| Polyacrylate copolymer (MW 11000) (maleic/acrylate ratio of 4:6) | 7.03 | 7.03 | 14.36 | 14.36 | 14.36 |
| Zeolite | 11.90 | 11.40 | 10.69 | 11.34 | 11.34 |
| Carbonate | 14.90 | 14.82 | 11.71 | 11.18 | 11.18 |
| Silicate | 12.00 | 12.00 | 12.37 | 12.38 | 12.38 |
| Protease ¹ | 0.016 | 0.016 | 0.046 | 0.046 | 0.046 |
| Lipase | - | - | 0.28 | - | - |
| Amylase ² | - | - | 0.62 | - | - |
| Cellulase | - | - | 0.48 | - | 0.70 |
| NOBS | 3.75 | 3.75 | 2.70 | 2.70 | 2.70 |
| PB1 | 3.53 | - | 2.60 | - | - |

Example 30Liquid Fabric Cleaning Compositions

| <u>Component</u> | <u>Example No.</u> |
|---|--------------------|
| | 28 |
| NaLAS (100%am) | 16 |
| Neodol | 21.5 |
| Citrate | 6.8 |
| EDDS | 1.2 |
| Dispersant | 1.3 |
| Perborate | 12 |
| Phenolsulfonate ester of N-nonanoyl-6-aminocaproic acid | 6 |
| Protease ¹ (% pure enzyme) | 0.03 |
| Amylase ³ | 0.40 |
| Carezyme | 0.03 |
| Solvent (BPP) | 18.5 |
| Polymer | 0.1 |
| Carbonate | 10 |
| FWA 15 | 0.2 |
| TiO ₂ | 0.5 |
| PEG 8000 | 0.4 |
| Perfume | 1.0-1.2 |
| Suds suppressor | 0.06 |
| Waters and minors | up to 100% |

Examples 31Liquid Fabric Cleaning Compositions

| <u>Component</u> | <u>Example No.</u> | |
|---------------------|--------------------|----------|
| | <u>A</u> | <u>B</u> |
| DI H ₂ O | 38.63 | - |
| MEA | 0.48 | 9.0 |
| NaOH | 4.40 | 1.0 |
| Pdiol | 4.00 | 10.0 |
| Citric acid | 2.50 | 2.0 |

² Protease other than the Protease¹ including but not limited to the additional proteases useful in the present invention described herein.

In Examples 28 D and E, any combination of the protease enzymes useful in the present invention recited herein, among others, are substituted for Protease¹ and Protease², with substantially similar results.

Examples 29

Liquid Fabric Cleaning Compositions

| <u>Component</u> | <u>Example No.</u> | |
|--|--------------------|----------|
| | <u>A</u> | <u>B</u> |
| C ₁₂₋₁₄ alkenyl succinic acid | 3.0 | 8.0 |
| Citric acid monohydrate | 10.0 | 15.0 |
| Sodium C ₁₂₋₁₅ alkyl sulphate | 8.0 | 8.0 |
| Sodium sulfate of C ₁₂₋₁₅ alcohol 2 times ethoxylated | - | 3.0 |
| C ₁₂₋₁₅ alcohol 7 times ethoxylated | - | 8.0 |
| C ₁₂₋₁₅ alcohol 5 times ethoxylated | 8.0 | - |
| Diethylene triamine penta (methylene phosphonic acid) | 0.2 | - |
| Oleic acid | 1.8 | - |
| Ethanol | 4.0 | 4.0 |
| Propanediol | 2.0 | 2.0 |
| Protease ¹ | 0.01 | 0.02 |
| Amylase ³ | 0.005 | 0.002 |
| Polyvinyl pyrrolidone | 1.0 | 2.0 |
| Suds suppressor | 0.15 | 0.15 |
| NaOH | up to pH 7.5 | |
| Perborate | 0.5 | 1 |
| Phenol sulphonate | 0.1 | 0.2 |
| Peroxidase | 0.4 | 0.1 |
| Waters and minors | up to 100 % | |

| | |
|-----------------------|-------------|
| Amylase ³ | 0.15 |
| Protease ¹ | 0.02 |
| Fatty Acid | 16.50 |
| Waters and minors | up to 100 % |

Example 34Liquid Fabric Cleaning Composition

The following liquid fabric cleaning composition of particular utility under Japanese machine wash conditions is prepared in accordance with the invention:

| Component | 34 |
|-------------------------------------|-------|
| AE2.5S | 15.00 |
| AS | 5.50 |
| N-Cocoyl N-methyl glucamine | 5.00 |
| Nonionic surfactant | 4.50 |
| Citric acid | 3.00 |
| Fatty acid | 5.00 |
| Base | 0.97 |
| Monoethanolamine | 5.10 |
| 1,2-Propanediol | 7.44 |
| EtOH | 5.50 |
| HXS | 1.90 |
| Boric acid | 3.50 |
| Ethoxylated tetraethylene-pentamine | 3.00 |
| SRP | 0.30 |

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| | | |
|---|-------------|--------|
| DTPA | 0.50 | 1.0 |
| FWA Premix (Br 15/MEA/NI 23-9) | 0.15 | 0.15 |
| Na C25AE1.80S | 23.50 | - |
| AE3S (H) | - | 4.0 |
| C11.8HLAS | 3.00 | 14.0 |
| Neodol | 2.00 | 6.0 |
| EtOH | 0.50 | 2.0 |
| Ca*Formate | 0.10 | 0.1 |
| Borax premix (Borax/MEA/Pdiol/CitricAcid) | 2.50 | - |
| C10 APA | 1.50 | - |
| TEPA 105 | 1.20 | - |
| FA C12-18 | 5.00 | - |
| Neptune LC | 0.50 | - |
| Dye | 0.0040 | 0.0015 |
| Cellulase | 0.053 | 0.2 |
| Amylase ³ | 0.15 | 0.2 |
| Protease ¹ | 0.1 | 0.1 |
| DC 2-3597 | 0.12 | 0.2 |
| Rapeseed FA | 6.50 | 4.0 |
| Waters and minors | up to 100 % | |

Example 32Liquid Fabric Cleaning Composition

| | |
|--------------------------------|-----------|
| <u>Component</u> | <u>30</u> |
| NaOH | 5.50 |
| Pdiol | 6.90 |
| Citric acid | 1.50 |
| DTPA | 1.50 |
| FWA Premix (Br 15/MEA/NI 23-9) | 0.15 |
| AE3S (H) | 2.50 |
| LAS (H) | 13.0 |
| Neodol | 2.00 |
| EtOH | 3.50 |
| Ca*Formate | 0.10 |
| Boric acid | 1.00 |
| Clay | 4.00 |

| | |
|-----------------------|------|
| Protease ¹ | 0.01 |
| Amylase ³ | 0.06 |
| Minors/inerts to 100% | |

Bar Fabric Cleaning Compositions

Bar fabric cleaning compositions of the present invention suitable for handwashing soiled fabrics typically contain an effective amount of one or more protease enzymes, preferably from about 0.001% to about 10%, more preferably from about 0.01% to about 1% by weight active protease enzyme of the composition. (See U.S. Patent No. 5,679,630 Examples).

Example 36

Bar Fabric Cleaning Compositions

| Component | Example No. | | | |
|--|-----------------|------|-------|-------|
| | A | B | C | D |
| Protease ¹ | 0.3 | - | 0.1 | 0.02 |
| Protease ² | - | - | 0.4 | 0.1 |
| Amylase ³ | 0.01 | 0.02 | 0.002 | 0.005 |
| C ₁₂ -C ₁₆ alkyl sulfate, Na | 20.0 | 20.0 | 20.0 | 20.00 |
| C ₁₂ -C ₁₄ N-methyl glucamide | 5.0 | 5.0 | 5.0 | 5.00 |
| C ₁₁ -C ₁₃ alkyl benzene sulfonate, Na | 10.0 | 10.0 | 10.0 | 10.00 |
| Sodium carbonate | 25.0 | 25.0 | 25.0 | 25.00 |
| Sodium tripolyphosphate | 7.0 | 7.0 | 7.0 | 7.00 |
| Zeolite A (0.1-.10 μ) | 5.0 | 5.0 | 5.0 | 5.00 |
| Carboxymethylcellulose | 0.2 | 0.2 | 0.2 | 0.20 |
| Polyacrylate (MW 1400) | 0.2 | 0.2 | 0.2 | 0.20 |
| Coconut monethanolamide | 5.0 | 5.0 | 5.0 | 5.00 |
| Brightener, perfume | 0.2 | 0.2 | 0.2 | 0.20 |
| CaSO ₄ | 1.0 | 1.0 | 1.0 | 1.00 |
| MgSO ₄ | 1.0 | 1.0 | 1.0 | 1.00 |
| Water | 4.0 | 4.0 | 4.0 | 4.00 |
| Filler* | balance to 100% | | | |

*Can be selected from convenient materials such as CaCO₃, talc, clay, silicates, and the like.

² Protease other than the Protease¹ including but not limited to the additional proteases useful in the present invention described herein.

| | |
|-----------------------|-------|
| Protease ¹ | 0.069 |
| Amylase ³ | 0.06 |
| Cellulase | 0.08 |
| Lipase | 0.18 |
| Brightener | 0.10 |
| Minors/inerts to 100% | |

Example 35Liquid Fabric Cleaning Composition

The following liquid fabric cleaning composition of particular utility under Japanese machine wash conditions and for fine fabrics is prepared in accordance with the invention:

| Component | 35 |
|-----------------------------|-------|
| AE2.5S | 2.16 |
| AS | 3.30 |
| N-Cocoyl N-methyl glucamine | 1.10 |
| Nonionic surfactant | 10.00 |
| Citric acid | 0.40 |
| Fatty acid | 0.70 |
| Base | 0.85 |
| Monoethanolamine | 1.01 |
| 1,2-Propanediol | 1.92 |
| EtOH | 0.24 |
| HXS | 2.09 |

WHAT IS CLAIMED IS:

1. A fabric and/or dishwashing and/or hard surface cleaning composition comprising:

(a) an effective amount of a protease variant wherein said protease variant includes a substitution of an amino acid residue with another naturally occurring amino acid residue at an amino acid residue position corresponding to position 103 of *Bacillus*

amyloliquefaciens subtilisin in combination with a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 1, 3, 4, 8, 9, 10, 12, 13, 16, 17, 18, 19, 20, 21, 22, 24, 27, 33, 37, 38, 42, 43, 48, 55, 57, 58, 61, 62, 68, 72, 75, 76, 77, 78, 79, 86, 87, 89, 97, 98, 99, 101, 102, 104, 106, 107, 109, 111, 114, 116, 117, 119, 121, 123, 126, 128, 130, 131, 133, 134, 137, 140, 141, 142, 146, 147, 158, 159, 160, 166, 167, 170, 173, 174, 177, 181, 182, 183, 184, 185, 188, 192, 194, 198, 203, 204, 205, 206, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 222, 224, 227, 228, 230, 232, 236, 237, 238, 240, 242, 243, 244, 245, 246, 247, 248, 249, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 265, 268, 269, 270, 271, 272, 274 and 275 of *Bacillus amyloliquefaciens* subtilisin; wherein when said protease variant includes a substitution of amino acid residues at positions corresponding to positions 103 and 76, there is also a substitution of an amino acid residue at one or more amino acid residue positions other than amino acid residue positions corresponding to positions 27, 99, 101, 104, 107, 109, 123, 128, 166, 204, 206, 210, 216, 217, 218, 222, 260, 265 or 274 of *Bacillus amyloliquefaciens* subtilisin;

(b) an amylase variant wherein said amylase variant is selected from the group consisting of:

(i) α -amylase characterized by having a specific activity at least 25% higher than the specific activity of Termamyl[®] at a temperature range of 25°C to 55°C and at a pH value in the range of 8 to 10, measured by Phadebas[®] α -amylase activity assay and/or;

(ii) α -amylase according to (i) comprising the amino acid sequence shown in SEQ ID No. 1 or an α -amylase being at least 80% homologous with the amino acid sequence shown in SEQ ID No. 1 and/or;

(iii) α -amylase according to (i) comprising the amino acid sequence shown in SEQ ID No. 2 or an α -amylase being at least 80% homologous with the amino acid sequence shown in SEQ ID No. 2 and/or;

(iv) α -amylase according to (i) comprising the following amino acid sequence N-terminal: His-His-Asn-Gly-Thr-Asn-Gly-Thr-Met-Met-Gln-Tyr-Phe-Glu-Trp-

In Examples 36 C and D any combination of the protease enzymes useful in the present invention recited herein, among others, are substituted for Protease¹ and Protease², with substantially similar results.

While particular embodiments of the subject invention have been described, it will be obvious to those skilled in the art that various changes and modifications of the subject invention can be made without departing from the spirit and scope of the invention. It is intended to cover, in the appended claims, all such modifications that are within the scope of the invention.

The compositions of the present invention can be suitably prepared by any process chosen by the formulator, non-limiting examples of which are described in U.S. 5,691,297 Nassano et al., issued November 11, 1997; U.S. 5,574,005 Welch et al., issued November 12, 1996; U.S. 5,569,645 Dinniwel et al., issued October 29, 1996; U.S. 5,565,422 Del Greco et al., issued October 15, 1996; U.S. 5,516,448 Capeci et al., issued May 14, 1996; U.S. 5,489,392 Capeci et al., issued February 6, 1996; U.S. 5,486,303 Capeci et al., issued January 23, 1996 all of which are incorporated herein by reference.

In addition to the above examples, the cleaning compositions of the present invention can be formulated into any suitable laundry detergent composition, non-limiting examples of which are described in U.S. 5,679,630 Baeck et al., issued October 21, 1997; U.S. 5,565,145 Watson et al., issued October 15, 1996; U.S. 5,478,489 Fredj et al., issued December 26, 1995; U.S. 5,470,507 Fredj et al., issued November 28, 1995; U.S. 5,466,802 Panandiker et al., issued November 14, 1995; U.S. 5,460,752 Fredj et al., issued October 24, 1995; U.S. 5,458,810 Fredj et al., issued October 17, 1995; U.S. 5,458,809 Fredj et al., issued October 17, 1995; U.S. 5,288,431 Huber et al., issued February 22, 1994 all of which are incorporated herein by reference.

Having described the invention in detail with reference to preferred embodiments and the examples, it will be clear to those skilled in the art that various changes and modifications may be made without departing from the scope of the invention and the invention is not to be considered limited to what is described in the specification.

217, 222, 230, 232, 248, 252, 257, 260, 261, 270 and 275, more preferably at positions 103, 236 and 245 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 211, 212, 213, 215, 217, 230, 232, 248, 252, 257, 260, 270 and 275.

4. The cleaning composition according to Claim 1 wherein said protease variant includes a substitution set selected from the group consisting of:

| | |
|---|---|
| 12/102/103/104/159/212/232/236/245/248/252; | 12/76/103/104/130/170/185/222/243/245; |
| 12/76/103/104/130/222/245/261; | 12/76/103/104/222/245; |
| 12/76/103/104/130/222/245; | |
| 61/68/103/104/159/232/236/245/248/252; | 62/103/104/159/213/232/236/245/248/252; |
| 62/103/104/109/159/213/232/236/245/248/252; | 62/103/104/159/232/236/245/248/252; |
| 62/101/103/104/159/212/213/232/236/245/248/252; | |
| 62/103/104/130/159/213/232/236/245/248/252; | |
| 68/103/104/159/232/236/245/248/252/270; | |
| 68/103/104/159/185/232/236/245/248/252; | 68/103/104/159/210/232/236/245/248/252; |
| 68/103/104/159/185/210/232/236/245/248/252; | 68/103/104/159/213/232/236/245/248/252; |
| 68/103/104/159/230/232/236/245; | 68/76/103/104/159/209/232/236/245; |
| 68/103/104/232/236/245/248/257/275; | 68/103/104/213/232/236/245/248/252; |
| 68/103/104/159/232/236/245/248/252; | 68/103/104/159/209/232/236/245; |
| 68/76/103/104/159/236; | 68/76/103/104/159/236/245; |
| 68/76/103/104/159/232/236/245; | 68/103/104/159/232/236/245/252; |
| 68/103/104/159/232/236/245; | 68/103/104/159/232/236/245/257; |
| 68/76/103/104/159/211/232/236/245; | 68/76/103/104/159/215/232/236/245; |
| 68/103/104/159/210/232/236/245; | 68/103/104/159/213/232/236/245/260; |
| 68/76/103/104/159/213/232/236/245/260; | 68/103/104/159/236; |
| 68/76/103/104/159/210/232/236/245/260; | 68/103/104/159/236/245; |
| 68/103/104/159/183/232/236/245/248/252; | 68/76/103/104/159/236/245; |
| 68/103/104/232/236/245/257/275; | 68/103/104/159/213/232/236/245; |
| 76/103/222/245; | 76/103/104/159/232/236/245; |
| 76/103/104/159/213/232/236/245/260; | 76/103/104/159; |
| 76/103/104/131/159/232/236/245/248/252; | 76/103/104/222/245; |
| 97/103/104/159/232/236/245/248/252; | |
| 98/102/103/104/159/212/232/236/245/248/252; | 98/103/104/159/232/236/245/248/252; |
| 101/103/104/159/232/236/245/248/252; | 102/103/104/159/232/236/245/248/252; |
| 103/104/159/232/236/245; | 103/104/159/232/236/245/248/252; |
| 103/104/159/205/209/232/236/245/257 | 103/104/159/232/245/248/252; |

Tyr-Leu-Pro-Asn-Asp (SEQ ID No. 3) or an α -amylase being at least 80% homologous with the amino acid sequence shown (SEQ ID No. 3) in the N-terminal and/or;

(v) α -amylase according to (i-iv) wherein the α -amylase is obtainable from an alkalophilic *Bacillus* species and/or;

(vi) α -amylase according to (v) wherein the amylase is obtainable from any of the strains NCIB 12289, NCIB 12512, NCIB 12513 and DSM 935 and/or;

(vii) α -amylase showing positive immunological cross-reactivity with antibodies raised against an α -amylase having an amino acid sequence corresponding respectively to SEQ ID No. 1, ID No. 2, or ID No. 3 and/or;

(viii) variant of a parent α -amylase, wherein the parent α -amylase (1) has one of the amino acid sequences shown in SEQ ID No. 1, ID No. 2, or ID No. 4, respectively, or (2) displays at least 80% homology with one or more of said amino acid sequences, and/or displays immunological cross-reactivity with an antibody raised against an α -amylase having one of said amino acid sequences, and/or is encoded by a DNA sequence which hybridizes with the same probe as a DNA sequence encoding an α -amylase having one of said amino acid sequences, in which variants: (A) at least one amino acid residue of said parent α -amylase has been deleted; and/or (B) at least one amino acid residue of said parent α -amylase has been replaced by a different amino acid residue; and/or (C) at least one amino acid residue has been inserted relative to said parent α -amylase; said variant having an α -amylase activity and exhibiting at least one of the following properties relative to said parent α -amylase: increased thermostability; increased stability towards oxidation; reduced Ca ion dependency; increased stability and/or α -amylolytic activity at neutral to relatively high pH values; increased α -amylolytic activity at relatively high temperature; and increase or decrease of the isoelectric point (pI) so as to better match the pI value for α -amylase variant to the pH of the medium; and

(c) one or more cleaning adjunct materials.

2. The cleaning composition according to Claim 1 wherein said protease variant is derived from a *Bacillus subtilis*, preferably *Bacillus lentus subtilis* or subtilisin 309.

3. The cleaning composition according to Claim 1 wherein said protease variant includes substitutions of the amino acid residues at position 103 and at one or more of the following positions 236 and 245, preferably at positions 103 and 236 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 211, 212, 213, 215, 217, 230, 232, 248, 252, 257, 260, 270 and 275 or at positions 103 and 245 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 104, 109, 130, 131, 159, 170, 183, 185, 205, 209, 210, 211, 212, 213, 215,

68A/103A/104I/159D/213E/232V/236H/245R/248D/252K;
68A/103A/104I/159D/230V/232V/236H/245R;
68A/76D/103A/104I/159D/209W/232V/236H/245R;
68A/103A/104I/232V/236H/245R/248D/257V/275H;
68A/103A/104I/232V/236H/245R/257V/275H;
68A/103A/104I/213E/232V/236H/245R/248D/252K;
68A/103A/104I/159D/232V/236H/245R/248D/252K;
68A/103A/104I/159D/210I/232V/236H/245R;
68A/103A/104I/159D/210L/232V/236H/245R;
68A/103A/104I/159D/213G/232V/236H/245R;
68A/103A/104I/159D/232V/236H/245R/248D/252K/270A;
76D/103A/222S/245R;
76D/103A/104I/159D/232V/236H/245R;
76D/103A/104I/159D;
76D/103A/104I/222S/245R;
76D/103A/104I/131V/159D/232V/236H/245R/248D/252K;
76D/103A/104I/159D/213R/232V/236H/245R/260A;
97E/103A/104I/159D/232V/236H/245R/248D/252K;
98L/103A/104I/159D/232V/236H/245R/248D/252K;
98L/102A/103A/104I/159D/212G/232V/236H/245R/248D/252K;
101G/103A/104I/159D/232V/236H/245R/248D/252K;
102A/103A/104I/159D/232V/236H/245R/248D/252K;
103A/104I/159D/232V/236H/245R/248D/252K;
103A/104I/159D/213R/232V/236H/245R/248D/252K;
103A/104I/130G/159D/232V/236H/245R/248D/252K;
103A/104I/159D/230V/236H/245R;
103A/104I/159D/217E/232V/236H/245R/248D/252K;
103A/104I/159D/236H/245R;
103A/104I/159D/248D/252K/270V;
103A/104I/159D/232V/236H/245R;
103A/104I/159D/205I/209W/232V/236H/245R;
103A/104I/159D/232V/236H/245R/257V;
103A/104I/159D/205I/209W/232V/236H/245R/257V;
103A/104I/131V/159D/232V/236H/245R/248D/252K;
103A/104I/159D/205I/209W/210I/232V/236H/245R/257V; and
103A/104I/159D/232V/245R/248D/252K.

6. The cleaning composition according to Claim 1 wherein said cleaning adjunct materials are selected from the group consisting of surfactants, solvents, buffers, enzymes, soil release agents, clay soil removal agents, dispersing agents, brighteners, suds suppressors, fabric softeners, suds boosters, enzyme stabilizers, builders, other bleaching agents, dyes, perfumes, chelants and mixtures thereof.
7. The cleaning composition according to Claim 6 wherein said cleaning adjunct materials comprise at least one deterative surfactant, preferably a branched surfactant, more preferably a mid-chained branched surfactant.
8. The cleaning composition according to Claim 7 wherein the cleaning adjunct materials comprise at least about 0.1% surfactant by weight of the composition, said surfactant comprising materials selected from the group consisting of alkyl benzene sulfonates, primary alkyl sulfates, secondary alkyl sulfates, alkyl alkoxy sulfates, alkyl alkoxy carboxylates, alkyl polyglycosides and their corresponding sulfated polyglycosides, alpha-sulfonated fatty acid esters, alkyl and alkyl phenol alkoxyates, betaines and sulfobetaines, amine oxides, N-methyl glucamides, nonionic primary alcohol ethoxyates, nonionic primary alcohol mixed ethoxy/propoxy, and mixtures thereof.
9. The cleaning composition according to Claim 8 further comprising at least about 5% builder selected from the group consisting of zeolites, polycarboxylates, layered silicates, phosphates, and mixtures thereof.
10. The cleaning composition according to Claim 6 wherein said cleaning adjunct materials comprise at least one deterative enzyme selected from the group consisting of cellulases, lipases, other amylases, phospholipases, other proteases, peroxidases and mixtures thereof.
11. The cleaning composition according to Claim 6 wherein said cleaning adjunct materials comprise at least one bleaching agent preferably selected from the group consisting of percarbonates, perborates and mixtures thereof, and optionally further comprising at least one bleach activator preferably selected from the group consisting of benzoyloxybenzenesulphonate (BOBS), nonanoyloxybenzenesulphonate (NOBS), decanoyloxybenzenesulphonate (C₁₀-OBS), octanoyloxybenzenesulphonate (C₈-OBS), perhydrolyzable esters, 4-[N-(nonaoyl) amino hexanoyloxy]-benzene sulfonate sodium salt (NACA-OBS), lauryloxybenzenesulphonate (LOBS or C₁₂-OBS), 10-undecenoyloxybenzenesulfonate (UDOBS or C₁₁-OBS with unsaturation in the 10

position), and decanoyloxybenzoic acid (DOBA) and mixtures thereof, and further optionally comprising a bleach catalyst, preferably 3-(3,4-dihydroisoquinolinium) propane sulfonate.

12. The cleaning composition according to Claim 1 wherein said cleaning composition is a fabric cleaning composition, preferably in the form of a liquid, granule, bar, tablet, gel, powder or foam, comprising at least about 5% surfactant and at least about 5% builder by weight of the composition.

13. The cleaning composition according to Claim 1 wherein said cleaning composition is a fabric cleaning composition comprising:

- (a) from about 0.0001% to about 10% by weight of said protease variant;
- (b) from about 0.0001% to about 0.1% by weight of said amylase variant;
- (c) at least about 5% by weight of a surfactant preferably selected from the group consisting of alkyl benzene sulfonates, primary alkyl sulfates, secondary alkyl sulfates, alkyl alkoxy sulfates, alkyl alkoxy carboxylates, alkyl polyglycosides and their corresponding sulfated polyglycosides, alpha-sulfonated fatty acid esters, alkyl and alkyl phenol alkoxyates, betaines and sulfobetaines, amine oxides, N-methyl glucamides, nonionic primary alcohol ethoxylates, nonionic primary alcohol mixed ethoxy/propoxy, and mixtures thereof; and wherein further the builder is selected from the group consisting of zeolites, polycarboxylates, layered silicates, phosphates, and mixtures thereof; and
- (d) at least about 5% by weight of a builder preferably selected from the group consisting of zeolites, polycarboxylates, layered silicates, phosphates, and mixtures thereof.

14. The cleaning composition according to Claim 25 is in the form of a concentrated granular fabric cleaning composition comprising at least about 15% surfactant.

15. A method for cleaning fabric, said method comprising contacting a fabric in need of cleaning with a cleaning composition according to Claims 12 or 13.

16. The cleaning composition according to Claim 1 wherein said cleaning composition is a dishwashing composition, preferably in the form of a liquid, granule, powder, gel or tablet, comprising:

- (a) from about 0.0001% to about 10% by weight of said protease variant;
- (b) from about 0.0001% to about 0.1% by weight of the dishwashing composition of said amylase variant; and
- (c) from about 0.1% to about 10% by weight of a surfactant.

17. A method for cleaning dishes, said method comprising contacting a dish in need of cleaning with a cleaning composition according to Claim 16.

18. A personal cleansing composition comprising:

(a) an effective amount of a protease variant wherein said protease variant includes a substitution of an amino acid residue with another naturally occurring amino acid residue at an amino acid residue position corresponding to position 103 of *Bacillus amyloliquefaciens* subtilisin in combination with a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 1, 3, 4, 8, 9, 10, 12, 13, 16, 17, 18, 19, 20, 21, 22, 24, 27, 33, 37, 38, 42, 43, 48, 55, 57, 58, 61, 62, 68, 72, 75, 76, 77, 78, 79, 86, 87, 89, 97, 98, 99, 101, 102, 104, 106, 107, 109, 111, 114, 116, 117, 119, 121, 123, 126, 128, 130, 131, 133, 134, 137, 140, 141, 142, 146, 147, 158, 159, 160, 166, 167, 170, 173, 174, 177, 181, 182, 183, 184, 185, 188, 192, 194, 198, 203, 204, 205, 206, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 222, 224, 227, 228, 230, 232, 236, 237, 238, 240, 242, 243, 244, 245, 246, 247, 248, 249, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 265, 268, 269, 270, 271, 272, 274 and 275 of *Bacillus amyloliquefaciens* subtilisin; wherein when said protease variant includes a substitution of amino acid residues at positions corresponding to positions 103 and 76, there is also a substitution of an amino acid residue at one or more amino acid residue positions other than amino acid residue positions corresponding to positions 27, 99, 101, 104, 107, 109, 123, 128, 166, 204, 206, 210, 216, 217, 218, 222, 260, 265 or 274 of *Bacillus amyloliquefaciens* subtilisin;

(b) an amylase variant wherein said amylase variant is selected from the group consisting of:

(i) α -amylase characterized by having a specific activity at least 25% higher than the specific activity of Termamyl[®] at a temperature range of 25°C to 55°C and at a pH value in the range of 8 to 10, measured by Phadebas[®] α -amylase activity assay and/or;

(ii) α -amylase according to (i) comprising the amino acid sequence shown in SEQ ID No. 1 or an α -amylase being at least 80% homologous with the amino acid sequence shown in SEQ ID No. 1 and/or;

(iii) α -amylase according to (i) comprising the amino acid sequence shown in SEQ ID No. 2 or an α -amylase being at least 80% homologous with the amino acid sequence shown in SEQ ID No. 2 and/or;

(iv) α -amylase according to (i) comprising the following amino acid sequence N-terminal: His-His-Asn-Gly-Thr-Asn-Gly-Thr-Met-Met-Gln-Tyr-Phe-Glu-Trp-

Tyr-Leu-Pro-Asn-Asp (SEQ ID No. 3) or an α -amylase being at least 80% homologous with the amino acid sequence shown (SEQ ID No. 3) in the N-terminal and/or;

(v) α -amylase according to (i-iv) wherein the α -amylase is obtainable from an alkalophilic *Bacillus* species and/or;

(vi) α -amylase according to (v) wherein the amylase is obtainable from any of the strains NCIB 12289, NCIB 12512, NCIB 12513 and DSM 935 and/or;

(vii) α -amylase showing positive immunological cross-reactivity with antibodies raised against an α -amylase having an amino acid sequence corresponding respectively to SEQ ID No. 1, ID No. 2, or ID No. 3 and/or;

(viii) variant of a parent α -amylase, wherein the parent α -amylase (1) has one of the amino acid sequences shown in SEQ ID No. 1, ID No. 2, or ID No. 4, respectively, or (2) displays at least 80% homology with one or more of said amino acid sequences, and/or displays immunological cross-reactivity with an antibody raised against an α -amylase having one of said amino acid sequences, and/or is encoded by a DNA sequence which hybridizes with the same probe as a DNA sequence encoding an α -amylase having one of said amino acid sequences, in which variants: (A) at least one amino acid residue of said parent α -amylase has been deleted; and/or (B) at least one amino acid residue of said parent α -amylase has been replaced by a different amino acid residue; and/or (C) at least one amino acid residue has been inserted relative to said parent α -amylase; said variant having an α -amylase activity and exhibiting at least one of the following properties relative to said parent α -amylase: increased thermostability; increased stability towards oxidation; reduced Ca ion dependency; increased stability and/or α -amylolytic activity at neutral to relatively high pH values; increased α -amylolytic activity at relatively high temperature; and increase or decrease of the isoelectric point (pI) so as to better match the pI value for α -amylase variant to the pH of the medium; and

(c) one or more cleaning adjunct materials.

19. The personal cleansing composition according to Claim 18 wherein said personal cleansing composition comprises:

(a) from about 0.001% to about 5%, preferably from about 0.001% to about 2%, more preferably from about 0.002% to about 0.8% by weight of said protease variant;

(b) from about 0.0001% to about 0.1% by weight of the personal cleansing composition of said amylase variant; and

(c) from about 0.1% to about 95% by weight of a surfactant system preferably comprising a surfactant selected from the group consisting of anionic carboxylates, amine oxides, alkyl glucosides, glucose amides, alkyl sulfates, alkyl ether sulfates, acyl isethionates, alkyl sulfosuccinates, alkyl phosphate esters, ethoxylated phosphate esters,

alkyl glyceryl ether sulfonates and mixtures thereof, more preferably comprising a surfactant selected from the group consisting of soaps, acylglutamates, alkyl sarcosinates, lauramine oxides, cocamine oxides, cocamindopropylamine oxides, decylglucosides, lauryl sulfates, laureth sulfates, C₁₂₋₁₈ acyl isethionates and mixtures thereof; and

(d) optionally, from about 0.05% to about 50% by weight of an enzyme stabilizer.

20. The personal cleansing composition according to Claim 19 wherein said surfactant is soap at a level of at least about 2%, preferably at least about 10%, more preferably at least about 25% by weight of the cleaning composition.

21. The personal cleansing composition according to Claim 20 wherein the ratio of soap to protease variant is from about 2,000:1 to about 8:1, preferably from about 400:1 to about 40:1.

22. A method for personal cleansing, said method comprising contacting a part of the human or lower animal body in need of cleaning with a cleaning composition according to Claim 18.

23. A fabric and/or dishwashing and/or hard surface cleaning composition comprising:

(a) an effective amount of a protease variant wherein said protease variant includes a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 62, 212, 230, 232, 252 and 257 of *Bacillus amyloliquefaciens* subtilisin;

(b) an amylase variant wherein said amylase variant is selected from the group consisting of:

(i) α -amylase characterized by having a specific activity at least 25% higher than the specific activity of Termamyl[®] at a temperature range of 25°C to 55°C and at a pH value in the range of 8 to 10, measured by Phadebas[®] α -amylase activity assay and/or;

(ii) α -amylase according to (i) comprising the amino acid sequence shown in SEQ ID No. 1 or an α -amylase being at least 80% homologous with the amino acid sequence shown in SEQ ID No. 1 and/or;

(iii) α -amylase according to (i) comprising the amino acid sequence shown in SEQ ID No. 2 or an α -amylase being at least 80% homologous with the amino acid sequence shown in SEQ ID No. 2 and/or;

(iv) α -amylase according to (i) comprising the following amino acid sequence N-terminal: His-His-Asn-Gly-Thr-Asn-Gly-Thr-Met-Met-Gln-Tyr-Phe-Glu-Trp-Tyr-Leu-Pro-Asn-Asp (SEQ ID No. 3) or an α -amylase being at least 80% homologous with the amino acid sequence shown (SEQ ID No. 3) in the N-terminal and/or;

(v) α -amylase according to (i-iv) wherein the α -amylase is obtainable from an alkalophilic *Bacillus* species and/or;

(vi) α -amylase according to (v) wherein the amylase is obtainable from any of the strains NCIB 12289, NCIB 12512, NCIB 12513 and DSM 935 and/or;

(vii) α -amylase showing positive immunological cross-reactivity with antibodies raised against an α -amylase having an amino acid sequence corresponding respectively to SEQ ID No. 1, ID No. 2, or ID No. 3 and/or;

(viii) variant of a parent α -amylase, wherein the parent α -amylase (1) has one of the amino acid sequences shown in SEQ ID No. 1, ID No. 2, or ID No. 4, respectively, or (2) displays at least 80% homology with one or more of said amino acid sequences, and/or displays immunological cross-reactivity with an antibody raised against an α -amylase having one of said amino acid sequences, and/or is encoded by a DNA sequence which hybridizes with the same probe as a DNA sequence encoding an α -amylase having one of said amino acid sequences, in which variants: (A) at least one amino acid residue of said parent α -amylase has been deleted; and/or (B) at least one amino acid residue of said parent α -amylase has been replaced by a different amino acid residue; and/or (C) at least one amino acid residue has been inserted relative to said parent α -amylase; said variant having an α -amylase activity and exhibiting at least one of the following properties relative to said parent α -amylase: increased thermostability; increased stability towards oxidation; reduced Ca ion dependency; increased stability and/or α -amylolytic activity at neutral to relatively high pH values; increased α -amylolytic activity at relatively high temperature; and increase or decrease of the isoelectric point (pI) so as to better match the pI value for α -amylase variant to the pH of the medium; and

(c) one or more cleaning adjunct materials.

24. The cleaning composition according to Claim 23 wherein said protease variant is derived from a *Bacillus* subtilisin, preferably *Bacillus lentus* subtilisin or subtilisin 309.

25. The cleaning composition according to Claim 23 wherein said protease variant includes substitutions of the amino acid residues at one or more of the following positions selected from the group consisting of:

1) position 62 and at one or more of the following positions 103, 104, 109, 159, 213, 232, 236, 245, 248 and 252;

- 2) position 212 and at one or more of the following positions 12, 98, 102, 103, 104, 159, 232, 236, 245, 248 and 252;
- 3) position 230 and at one or more of the following positions 68, 103, 104, 159, 232, 236 and 245;
- 4) position 232 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;
- 5) position 232 and at one or more of the following positions 103, 104, 236 and 245;
- 6) positions 232 and 103 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;
- 7) positions 232 and 104 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;
- 8) positions 232 and 236 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;
- 9) positions 232 and 245 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;
- 10) positions 232, 103, 104, 236 and 245 and at one or more of the following positions 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;
- 11) position 252 and at one or more of the following positions 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;
- 12) position 252 and at one or more of the following positions 103, 104, 236 and 245;
- 13) positions 252 and 103 and at one or more of the following positions 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;
- 14) positions 252 and 104 and at one or more of the following positions 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;

15) positions 252 and 236 and at one or more of the following positions 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;

16) positions 252 and 245 and at one or more of the following positions 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;

17) positions 252, 103, 104, 236 and 245 and at one or more of the following positions 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;

18) position 257 and at one or more of the following positions 68, 103, 104, 205, 209, 210, 232, 236, 245 and 275.

26. The cleaning composition according to Claim 23 wherein said protease variant includes a substitution set selected from the group consisting of:

12/102/103/104/159/212/232/236/245/248/252; 61/68/103/104/159/232/236/245/248/252;
 62/103/104/130/159/213/232/236/245/248/252; 62/103/104/159/213/232/236/245/248/252;
 62/103/104/109/159/213/232/236/245/248/252; 62/103/104/159/232/236/245/248/252;
 62/101/103/104/159/212/213/232/236/245/248/252;
 68/103/104/159/232/236/245/248/252/270;
 68/103/104/159/185/232/236/245/248/252; 68/103/104/159/210/232/236/245/248/252;
 68/103/104/159/185/210/232/236/245/248/252; 68/103/104/159/213/232/236/245/248/252;
 68/103/104/159/230/232/236/245; 68/76/103/104/159/209/232/236/245;
 68/103/104/232/236/245/248/257/275; 68/103/104/213/232/236/245/248/252;
 68/103/104/159/232/236/245/248/252; 68/103/104/159/209/232/236/245;
 68/76/103/104/159/232/236/245; 68/103/104/159/232/236/245/252;
 68/103/104/159/232/236/245; 68/103/104/159/232/236/245/257;
 68/76/103/104/159/211/232/236/245; 68/76/103/104/159/215/232/236/245;
 68/103/104/159/210/232/236/245; 68/103/104/159/213/232/236/245/260;
 68/76/103/104/159/213/232/236/245/260; 68/76/103/104/159/210/232/236/245/260;
 68/103/104/159/183/232/236/245/248/252; 68/103/104/232/236/245/257/275;
 68/103/104/159/213/232/236/245; 76/103/104/159/232/236/245;
 76/103/104/159/213/232/236/245/260; 76/103/104/131/159/232/236/245/248/252;
 97/103/104/159/232/236/245/248/252; 98/103/104/159/232/236/245/248/252;
 98/102/103/104/159/212/232/236/245/248/252; 101/103/104/159/232/236/245/248/252;
 102/103/104/159/232/236/245/248/252; 103/104/159/232/236/245;
 103/104/159/248/252/270; 103/104/159/232/236/245/248/252;
 103/104/159/205/209/232/236/245/257 103/104/159/232/245/248/252;

103/104/159/205/209/210/232/236/245/257; 103/104/159/213/232/236/245/248/252;
 103/104/159/217/232/236/245/248/252; 103/104/130/159/232/236/245/248/252;
 103/104/131/159/232/236/245/248/252; 103/104/159/205/209/232/236/245; and
 103/104/159/232/236/245/257.

27. The cleaning composition according to Claim 26 wherein said protease variant includes a substitution set selected from the group consisting of:

12R/102A/103A/104I/159D/212G/232V/236H/245R/248D/252K;
 61E/68A/103A/104I/159D/232V/236H/245R/248D/252K;
 62D/103A/104I/109R/159D/213R/232V/236H/245R/248D/252K;
 62D/103A/104I/159D/213R/232V/236H/245R/248D/252K;
 62D/103A/104I/159D/232V/236H/245R/248D/252K;
 62D/103A/104I/130G/159D/213R/232V/236H/245R/248D/252K;
 62D/101G/103A/104I/159D/212G/213R/232V/236H/245R/248D/252K;
 68A/76D/103A/104I/159D/213R/232V/236H/245R/260A;
 68A/76D/103A/104I/159D/210I/232V/236H/245R/260A;
 68A/103A/104I/159D/183D/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/209W/232V/236H/245R;
 68A/76D/103A/104I/159D/211R/232V/236H/245R;
 68A/76D/103A/104I/159D/215R/232V/236H/245R;
 68A/103A/104I/159D/213R/232V/236H/245R/260A;
 68A/76D/103A/104I/159D/232V/236H/245R;
 68A/103A/104I/159D/232V/236H/245R/252K;
 68A/103A/104I/159D/232V/236H/245R;
 68A/103A/104I/159D/232V/236H/245R/257V;
 68A/103A/104I/159D/185D/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/210L/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/185D/210L/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/213E/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/230V/232V/236H/245R;
 68A/76D/103A/104I/159D/209W/232V/236H/245R;
 68A/103A/104I/232V/236H/245R/248D/257V/275H;
 68A/103A/104I/232V/236H/245R/257V/275H;
 68A/103A/104I/213E/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/232V/236H/245R/248D/252K;
 68A/103A/104I/159D/210I/232V/236H/245R;
 68A/103A/104I/159D/210L/232V/236H/245R;

68A/103A/104I/159D/213G/232V/236H/245R;
68A/103A/104I/159D/232V/236H/245R/248D/252K/270A;
76D/103A/104I/159D/232V/236H/245R;
76D/103A/104I/131V/159D/232V/236H/245R/248D/252K;
76D/103A/104I/159D/213R/232V/236H/245R/260A;
97E/103A/104I/159D/232V/236H/245R/248D/252K;
98L/103A/104I/159D/232V/236H/245R/248D/252K;
98L/102A/103A/104I/159D/212G/232V/236H/245R/248D/252K;
101G/103A/104I/159D/232V/236H/245R/248D/252K;
102A/103A/104I/159D/232V/236H/245R/248D/252K;
103A/104I/159D/232V/236H/245R/248D/252K;
103A/104I/159D/213R/232V/236H/245R/248D/252K;
103A/104I/130G/159D/232V/236H/245R/248D/252K;
103A/104I/159D/217E/232V/236H/245R/248D/252K;
103A/104I/159D/248D/252K/270V;
103A/104I/159D/232V/236H/245R;
103A/104I/159D/205I/209W/232V/236H/245R;
103A/104I/159D/232V/236H/245R/257V;
103A/104I/159D/205I/209W/232V/236H/245R/257V;
103A/104I/131V/159D/232V/236H/245R/248D/252K;
103A/104I/159D/205I/209W/210I/232V/236H/245R/257V; and
103A/104I/159D/232V/245R/248D/252K.

28. The cleaning composition according to Claim 23 wherein said cleaning adjunct materials are selected from the group consisting of surfactants, solvents, buffers, enzymes, soil release agents, clay soil removal agents, dispersing agents, brighteners, suds suppressors, fabric softeners, suds boosters, enzyme stabilizers, builders, other bleaching agents, dyes, perfumes, chelants and mixtures thereof.

29. The cleaning composition according to Claim 28 wherein said cleaning adjunct materials comprise at least one deterative surfactant, preferably a branched surfactant, more preferably a mid-chained branched surfactant.

30. The cleaning composition according to Claim 28 wherein the cleaning adjunct materials comprise at least about 0.1% surfactant by weight of the composition, said surfactant comprising materials selected from the group consisting of alkyl benzene sulfonates, primary alkyl sulfates, secondary alkyl sulfates, alkyl alkoxy sulfates, alkyl

alkoxy carboxylates, alkyl polyglycosides and their corresponding sulfated polyglycosides, alpha-sulfonated fatty acid esters, alkyl and alkyl phenol alkoxyates, betaines and sulfobetaines, amine oxides, N-methyl glucamides, nonionic primary alcohol ethoxyates, nonionic primary alcohol mixed ethoxy/propoxy, and mixtures thereof.

31. The cleaning composition according to Claim 30 further comprising at least about 5% builder selected from the group consisting of zeolites, polycarboxylates, layered silicates, phosphates, and mixtures thereof.

32. The cleaning composition according to Claim 28 wherein said cleaning adjunct materials comprise at least one detergent enzyme selected from the group consisting of cellulases, lipases, amylases, phospholipases, other proteases, peroxidases and mixtures thereof.

33. The cleaning composition according to Claim 28 wherein said cleaning adjunct materials comprise at least one bleaching agent preferably selected from the group consisting of percarbonates, perborates and mixtures thereof, and optionally further comprising at least one bleach activator preferably selected from the group consisting of benzoyloxybenzenesulphonate (BOBS), nonanoyloxybenzenesulphonate (NOBS), decanoyloxybenzenesulphonate (C₁₀-OBS), octanoyloxybenzenesulphonate (C₈-OBS), perhydrolyzable esters, 4-[N-(nonaoyl) amino hexanoyloxy]-benzene sulfonate sodium salt (NACA-OBS), lauryloxybenzenesulphonate (LOBS or C₁₂-OBS), 10-undecenoyloxybenzenesulfonate (UDOBS or C₁₁-OBS with unsaturation in the 10 position), and decanoyloxybenzoic acid (DOBA) and mixtures thereof, and further optionally comprising a bleach catalyst, preferably 3-(3,4-dihydroisoquinolinium) propane sulfonate.

34. The cleaning composition according to Claim 23 wherein said cleaning composition is a fabric cleaning composition, preferably in the form of a liquid, granule, bar, tablet, gel, powder or foam, comprising at least about 5% surfactant and at least about 5% builder by weight of the composition.

35. The cleaning composition according to Claim 23 wherein said cleaning composition is a fabric cleaning composition comprising:

- (a) from about 0.0001% to about 10% by weight of said protease variant;
- (b) from about 0.0001% to about 0.1% by weight of the fabric cleaning composition of said amylase variant;

(c) at least about 5% by weight of a surfactant preferably selected from the group consisting of alkyl benzene sulfonates, primary alkyl sulfates, secondary alkyl sulfates, alkyl alkoxy sulfates, alkyl alkoxy carboxylates, alkyl polyglycosides and their corresponding sulfated polyglycosides, alpha-sulfonated fatty acid esters, alkyl and alkyl phenol alkoxyates, betaines and sulfobetaines, amine oxides, N-methyl glucamides, nonionic primary alcohol ethoxylates, nonionic primary alcohol mixed ethoxy/propoxy, and mixtures thereof; and wherein further the builder is selected from the group consisting of zeolites, polycarboxylates, layered silicates, phosphates, and mixtures thereof; and

(d) at least about 5% by weight of a builder preferably selected from the group consisting of zeolites, polycarboxylates, layered silicates, phosphates, and mixtures thereof.

36. The cleaning composition according to Claim 35 is in the form of a concentrated granular fabric cleaning composition comprising at least about 15% surfactant.

37. A method for cleaning fabric, said method comprising contacting a fabric in need of cleaning with a cleaning composition according to Claims 34 or 35.

38. The cleaning composition according to Claim 23 wherein said cleaning composition is a dishwashing composition, preferably in the form of a liquid, granule, powder, gel or tablet, comprising:

- (a) from about 0.0001% to about 10% by weight of said protease variant; and
- (b) from about 0.1% to about 10% by weight of a surfactant.

39. A method for cleaning dishes, said method comprising contacting a dish in need of cleaning with a cleaning composition according to Claim 38.

40. A personal cleansing composition comprising:

(a) an effective amount of a protease variant wherein said protease variant includes a substitution of an amino acid residue with another naturally occurring amino acid residue at one or more amino acid residue positions corresponding to positions 62, 212, 230, 232, 252 and 257 of *Bacillus amyloliquefaciens* subtilisin;

(b) an amylase variant wherein said amylase variant is selected from the group consisting of:

(i) α -amylase characterized by having a specific activity at least 25% higher than the specific activity of Termamyl[®] at a temperature range of 25°C to 55°C and at a pH value in the range of 8 to 10, measured by Phadebas[®] α -amylase activity assay and/or;

(ii) α -amylase according to (i) comprising the amino acid sequence shown in SEQ ID No. 1 or an α -amylase being at least 80% homologous with the amino acid sequence shown in SEQ ID No. 1 and/or;

(iii) α -amylase according to (i) comprising the amino acid sequence shown in SEQ ID No. 2 or an α -amylase being at least 80% homologous with the amino acid sequence shown in SEQ ID No. 2 and/or;

(iv) α -amylase according to (i) comprising the following amino acid sequence N-terminal: His-His-Asn-Gly-Thr-Asn-Gly-Thr-Met-Met-Gln-Tyr-Phe-Glu-Trp-Tyr-Leu-Pro-Asn-Asp (SEQ ID No. 3) or an α -amylase being at least 80% homologous with the amino acid sequence shown (SEQ ID No. 3) in the N-terminal and/or;

(v) α -amylase according to (i-iv) wherein the α -amylase is obtainable from an alkalophilic *Bacillus* species and/or;

(vi) α -amylase according to (v) wherein the amylase is obtainable from any of the strains NCIB 12289, NCIB 12512, NCIB 12513 and DSM 935 and/or;

(vii) α -amylase showing positive immunological cross-reactivity with antibodies raised against an α -amylase having an amino acid sequence corresponding respectively to SEQ ID No. 1, ID No. 2, or ID No. 3 and/or;

(viii) variant of a parent α -amylase, wherein the parent α -amylase (1) has one of the amino acid sequences shown in SEQ ID No. 1, ID No. 2, or ID No. 4, respectively, or (2) displays at least 80% homology with one or more of said amino acid sequences, and/or displays immunological cross-reactivity with an antibody raised against an α -amylase having one of said amino acid sequences, and/or is encoded by a DNA sequence which hybridizes with the same probe as a DNA sequence encoding an α -amylase having one of said amino acid sequences, in which variants: (A) at least one amino acid residue of said parent α -amylase has been deleted; and/or (B) at least one amino acid residue of said parent α -amylase has been replaced by a different amino acid residue; and/or (C) at least one amino acid residue has been inserted relative to said parent α -amylase; said variant having an α -amylase activity and exhibiting at least one of the following properties relative to said parent α -amylase: increased thermostability; increased stability towards oxidation; reduced Ca ion dependency; increased stability and/or α -amylolytic activity at neutral to relatively high pH values; increased α -amylolytic activity at relatively high temperature; and increase or decrease of the isoelectric point (pI) so as to better match the pI value for α -amylase variant to the pH of the medium; and

(c) one or more cleaning adjunct materials.

41. The personal cleansing composition according to Claim 40 wherein said personal cleansing composition comprises:

(a) from about 0.001% to about 5%, preferably from about 0.001% to about 2%, more preferably from about 0.002% to about 0.8% by weight of said protease variant;

(b) from about 0.0001% to about 0.1% by weight of the personal cleansing composition of said amylase variant; and

(c) from about 0.1% to about 95% by weight of a surfactant system preferably comprising a surfactant selected from the group consisting of anionic carboxylates, amine oxides, alkyl glucosides, glucose amides, alkyl sulfates, alkyl ether sulfates, acyl isethionates, alkyl sulfosuccinates, alkyl phosphate esters, ethoxylated phosphate esters, alkyl glyceryl ether sulfonates and mixtures thereof, more preferably comprising a surfactant selected from the group consisting of soaps, acylglutamates, alkyl sarcosinates, lauramine oxides, cocamine oxides, cocamindopropylamine oxides, decylglucosides, lauryl sulfates, laureth sulfates, C₁₂₋₁₈ acyl isethionates and mixtures thereof; and

(d) optionally, from about 0.05% to about 50% by weight of an enzyme stabilizer.

42. The personal cleansing composition according to Claim 41 wherein said surfactant is soap at a level of at least about 2%, preferably at least about 10%, more preferably at least about 25% by weight of the cleaning composition.

43. The personal cleansing composition according to Claim 42 wherein the ratio of soap to protease variant is from about 2,000:1 to about 8:1, preferably from about 400:1 to about 40:1.

44. A method for personal cleansing, said method comprising contacting a part of the human or lower animal body in need of cleaning with a cleaning composition according to Claim 40.

45. A method for pretreating a fabric in need of cleaning, said method comprising contacting said fabric prior to washing said fabric with an aqueous solution containing a surfactant with a bleaching composition according to Claims 12 or 13.

46. A method for pretreating a fabric in need of cleaning, said method comprising contacting said fabric prior to washing said fabric with an aqueous solution containing a surfactant with a bleaching composition according to Claims 34 or 35.

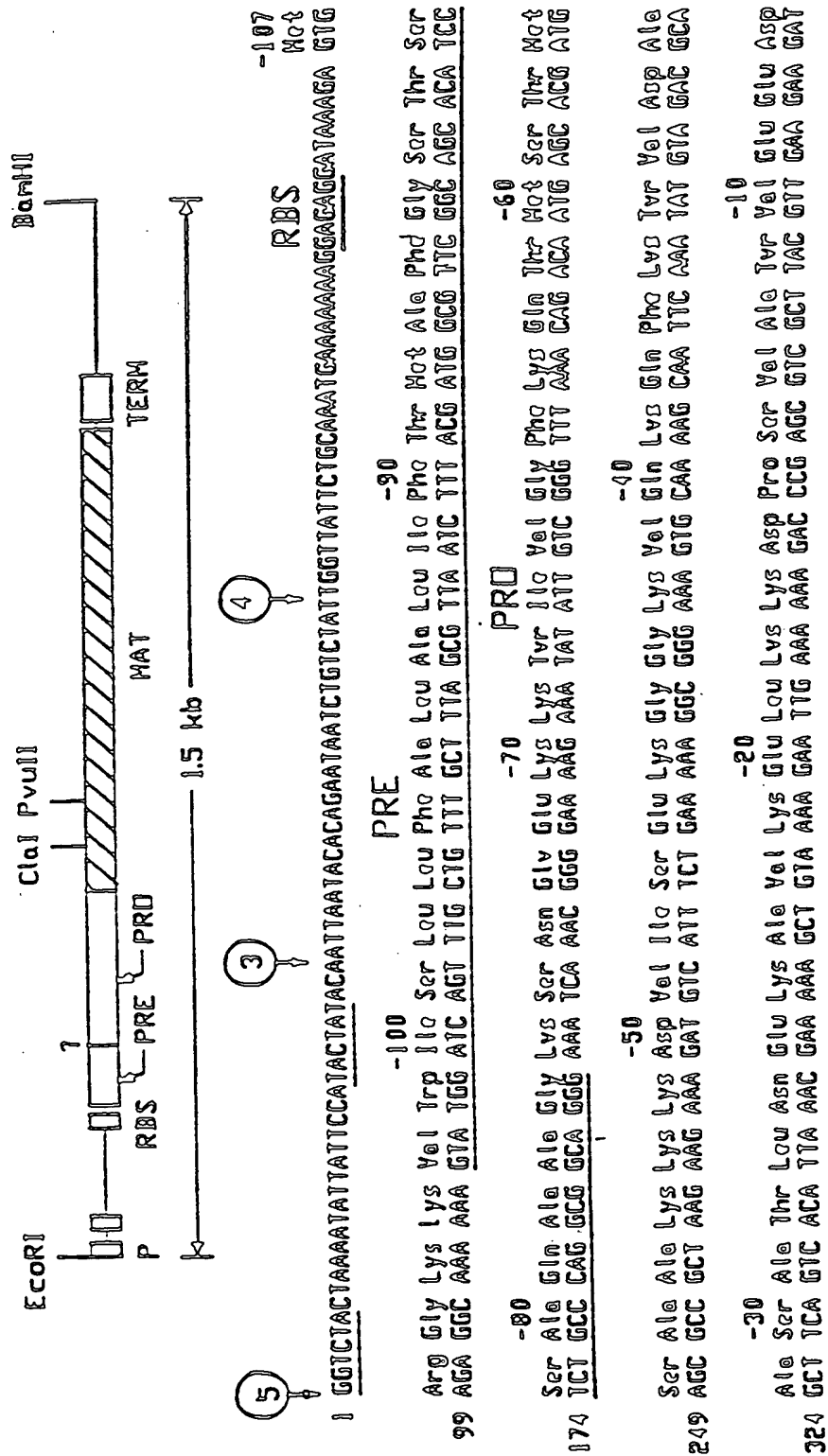


FIG. 1A

-1-
MAT

His Bol Ala His Ala Tyr Ala Gln Ser Val Pro Tyr Gly Val Ser Gln Ile Lys Ala Pro Ala Leu His Ser Gln
 399 CAC GTA GCA CAT GCG TAC GCG CAG TCC GTG CCT TAC GGC GTA TCA CAA ATT AAA GCC CCT GCT CTG CAC TCT CAA

20
 Gly Tyr Thr Gly Ser Asn Val Lys Val Ala Val Ile Asp Ser Gly Ile Asp Ser Ser His Pro Asn Leu Lys Val
 474 GGC TAC ACT GGA TCA AAT GTT AAA GTA GCG GTT ATC GAC AGC GGT ATC GAT TCT TCT CAT CCT GAT TTA AAG GTA

30
 Ala Gly Gly Ala Ser Met Val Pro Ser Glu Thr Asn Pro Phe Gln Asp Asn Asn Ser His Gly Thr His Val Ala
 549 GCA AGC GGA GCC AGC ATG GTT CCT TCT GAA ACA AAT CCT TTC CAA GAC AAC AAC TCT CAC GGA ACT CAC GTT GCC

50
 Pro Asn
 60 Asp
 Ser Ala 90
 Gly Thr Val Ala Ala Leu Asn Asn Ser Ile Gly Val Leu Gly Val Ala Pro Ser Ala Ser Leu Tyr Ala Val Lys
 624 GGC ACA GTT GCG GCT CTT AAT AAC TCA ATC GGT GTA TTA GGC GTT GCG CCA AGC GCA TCA CTT TAC GCT GTA AAA

70
 Asp Ala 100
 Val Leu Gly Ala Asp Gly Ser Gly Gln Tyr Ser Trp Ile Ile Asn Gly Ile Glu Trp Ala Ile Ala Asn Asn Met
 699 GTT CTC GGT GCT GAC GGT TCC GGC CAA TAC AGC TGG ATC ATT AAC GGA ATC GAG TGG GCG ATC GCA AAC AAT ATG

110
 120
 Asp Val Ile Asn Met Ser Leu Gly Gly Pro Ser Gly Ser Ala Ala Leu Lys Ala Ala Val Asp Lys Ala Val Ala
 774 GAC GTT ATT AAC ATG AGC CTC GGC GGA CCT TCT GGT TCT GCT GCT TTA AAA GCG GCA GTT GAT AAA GCC GTT GCA

130
 140
 Ser Thr 160
 Ser Gly Val Val Val Ala Ala Ala Gly Asn Glu Gly Thr Ser Gly Ser Ser Ser Thr Val Gly Tyr Pro Gly
 849 TCC GGC GTC GTA GTC GTT GCG GCA GCC GGT AAC GAA GGC ACT TCC GGC AGC TCA AGC ACA GTG GGC TAC CCT GGT

FIG-1B

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170 Lys Tyr Pro Ser Val Ile Ala Val Gly Ala Val Asp Ser Ser Asn Gln Arg Ala Ser Phe Ser Ser Val Gly Pro
924 AAA TAC CCT TCT GTC ATT GCA GTA GGC GCT GTT GAC AGC AGC AAC CAA AGA GCA TCT TTC TCA AGC GTA GGA CCT

200 Glu Leu Asp Val Met Ala Pro Gly Val Ser Ile Gln Ser Thr Leu Pro Gly Asn Lys Tyr Gly Ala Tyr Asn Gly
999 GAG CTT CAT GTC ATG GCA CCT GGC GTA TCT ATC CAA AGC AGC CTT CCT GGA AAC AAA TAC GGG GCG TAC AAC GGT

220 Thr Ser Met Ala Ser Pro His Val Ala Gly Asl Ala Ala Leu Ile Leu Ser Lys His Pro Asn Trp Thr Asn Thr
1074 ACG TCA ATG GCA TCT CCG CAC GGT GCC GGA GCG GCT GCT ATT CTT TCT AAG CAC CCG AAC TGG ACA AAC ACT

250 Gln Val Arg Ser Ser Leu Glu Asn Thr Thr Thr Lys Leu Gly Asp Ser Phe Tyr Tyr Gly Lys Gly Leu Ile Asn
1149 CAA GTC CCG AGC AGT TTA GAA AAC ACC ACT ACA AAA CTT GGT GAT TCT TTG TAC TAT GGA AAA GGG CTG ATC AAC

270 Val Gln Ala Ala Ala Gln DC
1224 GTA CAA GCG GCA GCT CAG TAA AACAATAAAACCGGCCCTGGCCCCCGGGTTTTTATATATTTTCTTCCCTCCGCATGTTCAATCCGCCTC

1316 ATAATCGACGGATGGCTCCCTCTCAAAATTTTAACGAGAAACGGGGGTGACCCCGGCACGTCGGGTACGGCAACTCCGAAACGCTTCAATCGCCG

1416 CTTCCCGGTTCCGGTCAGCTCAATGCCATAACGGTGGGGGGGTTTTTCCGTATACGGGAGAGGGCATTCGTATCGGATC

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TERM

FIG.-1C

CONSERVED RESIDUES IN SUBTILISINS FROM
BACILLUS AMYLOLIQUEFACTENS

| | | | | | | | | | | | | | | | | | | | | | |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|-----|
| 1 | A | Q | S | V | P | . | G | . | . | . | . | . | A | P | A | . | H | . | . | G | 20 |
| 21 | . | T | G | S | . | V | K | V | A | V | . | D | . | G | . | . | . | . | H | P | 40 |
| 41 | D | L | . | . | . | G | G | A | S | . | V | P | . | . | . | . | . | . | Q | D | 60 |
| 61 | . | N | . | H | G | T | H | V | A | G | T | . | A | A | L | N | N | S | I | G | 80 |
| 81 | V | L | G | V | A | P | S | A | . | L | Y | A | V | K | V | L | G | A | . | G | 100 |
| 101 | S | G | . | . | S | . | L | . | . | G | . | E | W | A | . | N | . | . | . | . | 120 |
| 121 | V | . | N | . | S | L | G | . | P | S | . | S | . | . | . | . | . | A | . | . | 140 |
| 141 | . | . | . | . | G | V | . | V | V | A | A | . | G | N | . | G | . | . | . | . | 160 |
| 161 | . | . | . | . | . | Y | P | . | . | Y | . | . | . | . | A | V | G | A | . | . | 180 |
| 181 | D | . | . | N | . | . | A | S | F | S | . | . | G | . | . | L | D | . | . | A | 200 |
| 201 | P | G | V | . | . | Q | S | T | . | P | G | . | . | Y | . | . | . | N | G | T | 220 |
| 221 | S | M | A | . | P | H | V | A | G | A | A | A | L | . | . | . | . | K | . | . | 240 |
| 241 | W | . | . | Q | . | R | . | . | L | . | N | T | . | . | . | L | G | . | . | . | 260 |
| 261 | . | . | Y | G | . | G | L | . | N | . | . | A | A | . | . | . | . | . | . | . | 270 |

FIG. 2

Comparison of subtlisin sequences from:

B. amyloliquefaciens

B. subtilis

B. licheniformis

B. lentus

| | | | |
|---|---|---|---|
| 101 | 10 | 20 | 30 |
| A A Q Q S V P Y G V S Q I K A P A L H S Q G Y T G S N V A V I D S G I D S S H P | A A Q Q S V P Y G V S Q I K A P A L H S Q G Y T G S N V A V I D S G I D S S H P | A A Q Q S V P Y G V S Q I K A P A L H S Q G Y T G S N V A V I D S G I D S S H P | A A Q Q S V P Y G V S Q I K A P A L H S Q G Y T G S N V A V I D S G I D S S H P |

[illegible][illegible][illegible]

FIG 3/A

161 170 180 190
SSSTVCGYPPGKYPPSSVIAVGAVDSSNQRASSFSSVGPPELLDDVMA
STSTVGYPPAKYPPSTTIAVGAVDSSNQRASSFSSVGAELLEVMMA
STNTIGYPPAKYDSSVIAVGAVDSSNNRRASFSSQYGAGLDIVA
* * * I S Y P A R Y A N A M A V G A T D Q N N N R A S F S Q Y G A G L D I V A

201 210 220 230
PGVBIQSTLPCHNKYGAYNGTSHASPHVAGAAALILSKHPTN
PGVSIQSTLPCHNKYGAYNGTSHASPHVAGAAALILSKHPTN
PGAGVYSTYPTNTYATLNGTSHASPHVAGAAALILSKHPTN
PGVNVQSTYPCSTYASLNGTSHASPHVAGAAALILSKHPTN

241 250 260 270
HTNTQVRRSSLENTTKLGDSFY YGKGLIN VQAAQ
HTNAQQVRRRLLESSTATYLLGNSFF YGKGLIN VQAAQ
LSASQQVRRNHLKNTATSLGSTNLYGSGLVNVEAAQ
WSNVQI RNNHLLKNTATSLGSTNLYGSGLVNVEAAQ

FIG 3/B

SEQUENCE DESCRIPTION : SEQ ID No. 1

His His Asn Gly Thr Asn Gly Thr Met Met Gln Tyr Phe Glu Trp Tyr
 1 5 10 15
 Leu Pro Asn Asp Gly Asn His Trp Asn Arg Leu Arg Asp Asp Ala Ala
 20 25 30
 Asn Leu Lys Ser Lys Gly Ile Thr Ala Val Trp Ile Pro Pro Ala Trp
 35 40 45
 Lys Gly Thr Ser Gln Asn Asp Val Gly Tyr Gly Ala Tyr Asp Leu Tyr
 50 55 60
 Asp Leu Gly Glu Phe Asn Gln Lys Gly Thr Val Arg Thr Lys Tyr Gly
 65 70 75 80
 Thr Arg Asn Gln Leu Gln Ala Ala Val Thr Ser Leu Lys Asn Asn Gly
 85 90 95
 Ile Gln Val Tyr Gly Asp Val Val Met Asn His Lys Gly Gly Ala Asp
 100 105 110
 Gly Thr Glu Ile Val Asn Ala Val Glu Val Asn Arg Ser Asn Arg Asn
 115 120 125
 Gln Glu Thr Ser Gly Glu Tyr Ala Ile Glu Ala Trp Thr Lys Phe Asp
 130 135 140
 Phe Pro Gly Arg Gly Asn Asn His Ser Ser Phe Lys Trp Arg Trp Tyr
 145 150 155 160
 His Phe Asp Gly Thr Asp Trp Asp Gln Ser Arg Gln Leu Gln Asn Lys
 165 170 175
 Ile Tyr Lys Phe Arg Gly Thr Gly Lys Ala Trp Asp Trp Glu Val Asp
 180 185 190
 Thr Glu Asn Gly Asn Tyr Asp Tyr Leu Met Tyr Ala Asp Val Asp Met
 195 200 205
 Asp His Pro Glu Val Ile His Glu Leu Arg Asn Trp Gly Val Trp Tyr
 210 215 220
 Thr Asn Thr Leu Asn Leu Asp Gly Phe Arg Ile Asp Ala Val Lys His
 225 230 235 240
 Ile Lys Tyr Ser Phe Thr Arg Asp Trp Leu Thr His Val Arg Asn Thr
 245 250 255
 Thr Gly Lys Pro Met Phe Ala Val Ala Glu Phe Trp Lys Asn Asp Leu
 260 265 270

Gly Ala Ile Glu Asn Tyr Leu Asn Lys Thr Ser Trp Asn His Ser Val
 275 280 285
 Phe Asp Val Pro Leu His Tyr Asn Leu Tyr Asn Ala Ser Asn Ser Gly
 290 295 300
 Gly Tyr Tyr Asp Met Arg Asn Ile Leu Asn Gly Ser Val Val Gln Lys
 305 310 315 320
 His Pro Thr His Ala Val Thr Phe Val Asp Asn His Asp Ser Gln Pro
 325 330 335
 Gly Glu Ala Leu Glu Ser Phe Val Gln Gln Trp Phe Lys Pro Leu Ala
 340 345 350
 Tyr Ala Leu Val leu Thr Arg Glu Gln Gly Tyr Pro Ser Val Phe Tyr
 355 360 365
 Gly Asp Tyr Tyr Gly Ile Pro Thr His Gly Val Pro Ala Met Lys Ser
 370 375 380
 Lys Ile Asp Pro leu Leu Gln Ala Arg Gln Thr Phe Ala Tyr Gly Thr
 385 390 395 400
 Gln His Asp Tyr Phe Asp His His Asp Ile Ile Gly Trp Thr Arg Glu
 405 410 415
 Gly Asn Ser Ser His Pro Asn Ser Gly Leu Ala Thr Ile Met Ser Asp
 420 425 430
 Gly Pro Gly Gly Asn Lys Trp Met Tyr Val Gly Lys Asn Lys Ala Gly
 435 440 445
 Gln Val Trp Arg Asp Ile Thr Gly Asn Arg Thr Gly Thr Val Thr Ile
 450 455 460
 Asn Ala Asp Gly Trp Gly Asn Phe Ser Val Asn Gly Gly Ser Val Ser
 465 470 475 480
 Val Trp Val Lys Gln
 485

SEQUENCE DESCRIPTION : SEQ ID No. 2

His His Asn Gly Thr Asn Gly Thr Met Met Gln Tyr Phe Glu Trp His
 1 5 10 15
 Leu Pro Asn Asp Gly Asn His Trp Asn Arg Leu Arg Asp Asp Ala Ser
 20 25 30
 Asn Leu Arg Asn Arg Gly Ile Thr Ala Ile Trp Ile Pro Pro Ala Trp
 35 40 45
 Lys Gly Thr Ser Gln Asn Asp Val Gly Tyr Gly Ala Tyr Asp Leu Tyr
 50 55 60
 Asp Leu Gly Glu Phe Asn Gln Lys Gly Thr Val Arg Thr Lys Tyr Gly
 65 70 75
 Thr Arg Ser Gln Leu Glu Ser Ala Ile His Ala Leu Lys Asn Asn Gly
 80 85 90 95
 Val Gln Val Tyr Gly Asp Val Val Met Asn His Lys Gly Gly Ala Asp
 100 105 110
 Ala Thr Glu Asn Val Leu Ala Val Glu Val Asn Pro Asn Asn Arg Asn
 115 120 125
 Gln Glu Ile Ser Gly Asp Tyr Thr Ile Glu Ala Trp Thr Lys Phe Asp
 130 135 140
 Phe Pro Gly Arg Gly Asn Thr Tyr Ser Asp Phe Lys Trp Arg Trp Tyr
 145 150 155
 His Phe Asp Gly Val Asp Trp Asp Gln Ser Arg Gln Phe Gln Asn Arg
 160 165 170 175
 Ile Tyr Lys Phe Arg Gly Asp Gly Lys Ala Trl Asp Trp Glu Val Asp
 180 185 190
 Ser Glu Asn Gly Asn Tyr Asp Tyr Leu Met Tyr Ala Asp Val Asp Met
 195 200 205
 Asp His Pro Glu Val Val Asn Glu Leu Arg Arg Trp Gly Glu Trp Tyr
 210 215 220
 Thr Asn Thr Leu Asn Leu Asp Gly Phe Arg Ile Asp Ala Val Lys His
 225 230 235
 Ile Lys Tyr Ser Phe Thr Arg Asp Trp Leu Thr His Val Arg Asn Ala
 240 245 250 255
 Thr Gly Lys Glu Met Phe Ala Val Ala Glu Phe Trp Lys Asn Asp Leu
 260 265 270

Gly Ala Leu Glu Asn Tyr Leu Asn Lys Thr Asn Trp Asn His Ser Val
 275 280 285
 Phe Asp Val Pro Leu His Tyr Asn Leu Tyr Asn Ala Ser Asn Ser Gly
 290 295 300
 Gly Asn Tyr Asp Met Ala Lys Leu Leu Asn Gly Thr Val Val Gln Lys
 305 310 315
 His Pro Met His Ala Val Thr Phe Val Asp Asn His Asp Ser Gln Pro
 320 325 330 335
 Gly Glu Ser Leu Glu Ser Phe Val Gln Glu Trp Phe Lys Pro Leu Ala
 340 345 350
 Tyr Ala Leu Ile Leu Thr Arg Glu Gln Gly Tyr Pro Ser Val Phe Tyr
 355 360 365
 Gly Asp Tyr Tyr Gly Ile Pro Thr His Ser Val Pro Ala Met Lys Ala
 370 375 380
 Lys Ile Asp Pro Ile Leu Glu Ala Arg Gln Asn Phe Ala Tyr Gly Thr
 385 390 395
 Gln His Asp Tyr Phe Asp His His Asn Ile Ile Gly Trp Thr Arg Glu
 400 405 410 415
 Gly Asn Thr Thr His Pro Asn Ser Gly Leu Ala Thr Ile Met Ser Asp
 420 425 430
 Gly Pro Gly Gly Glu Lys Trp Met Tyr Val Gly Gln Asn Lys Ala Gly
 435 440 445
 Gln Val Trp His Asp Ile Thr Gly Asn Lys Pro Gly Thr Val Thr Ile
 450 455 460
 Asn Ala Asp Gly Trp Ala Asn Phe Ser Val Asn Gly Gly Ser Val Ser
 465 470 475
 Ile Trp Val Lys Arg
 480

SEQUENCE DESCRIPTION : SEQ ID No. 3

His-His-Asn-Gly-Thr-Asn-Gly-Thr-Met-Met-Gln-Tyr-Phe-Glu-Trp-Tyr-Leu-Pro-
Asn-Asp

SEQUENCE DESCRIPTION : SEQ ID No. 4

| | | | | |
|------------|------------|------------|------------|------------|
| AAPFNGTMMQ | YFEWYLPDDG | TLWTKVANE | NNLSSLGITA | LWLPPAYKGT |
| SRSDVGYGVY | DLYDLGEFNO | KGAVRTKYGT | KAQYLOAIQA | |
| | AAAAGMOVYA | | | |
| DVVFHKGGA | DGTEWVDAVE | VNPSDRNQEI | SGTYQIQAWT | KDFPPGRGNT |
| YSSFKWRWYH | FDGVDWDESR | KLSRIYKFRG | IGKAWDWEVD | |
| TENGNYDYLM | | | | |
| YADLDMOHPE | VVTELKSWGK | WYVNTTNIDG | FRLDAVKHIK | FSFFPDWLSO |
| VRSGTGKPLF | TVGEYWSYDI | NKLHNYIMKT | NGTMSLFDAP | LHNKFYTASK |
| SGGTDFMRTL | MTNTLMKDOP | TLAVTFVDNH | DTEPGQALQS | |
| | WVDPWFKPLA | | | |
| YAFILTRQEG | YPCVFYGDYY | GIPQYNIPSL | KSKIDPLLIA | RRDYAYGTOH |
| DYLDHSDIIG | WTREGVTEKP | GSGLAALITD | GPGGSKWMYV | |
| GKQHAGKVFY | | | | |
| DLTGNRSDTV | TINSDGWGEF | KVNGGSVSVW | VPRKTTVSTI | AWSITTRPWT |
| DEFVRWTEPR | LVAWP | | | |

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